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SELECTED WATER RESOURCES ABSTRACTS

A monthly publication of the Geological Survey
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The Secretary of the Interior has deterimined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical has been approved by the Office of Management and Budget through September 1991.

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. administration.

PREFACE

Selected Water Resources Abstracts, a monthly journal, includes abstracts of current and earlier pertinent monographs, journal articles, reports, and other publication formats. These documents cover water resources as treated in the life, physical, and social sciences and the related engineering and legal aspects of the characteristics, supply condition, conservation, control, use, or management of water resources. Each abstract includes a full bibliographic citation and a set of descriptors which are listed in the **Water Resources Thesaurus.** The abstract entries are classified into 10 fields and 60 groups similar to the water resources research categories established by the Committee on Water Resources Research of the then Federal Council for Science and Technology.

Selected Water Resources Abstracts is designed to serve the scientific and technical information needs of scientists, engineers, and managers as one of several services of the Water Resources Scientific Information Center. The cumulative SWRA file from 1968 and monthly updates are available also in magnetic tape through lease from NTIS.

THE WATER RESOURCES SCIENTIFIC INFORMATION CENTER DOES NOT PROVIDE COPIES OF DOCUMENTS ABSTRACTED IN THIS JOURNAL. Sufficient bibliographic information is given to enable readers to order the desired documents from local libraries or other sources.

Comments and suggestions concerning the contents and arrangement of this bulletin are welcome.

Water Resources Scientific
Information Center
U.S. Geological Survey
MS 425 National Center
Reston, VA 22092

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Includes the following Groups: General; Precipitation; Snow, Ice, and Frost; Evaporation and Transpiration; Streamflow and Runoff; Groundwater; Water in Soils; Lakes; Water in Plants; Erosion and Sedimentation; Chemical Processes; Estuaries.

03 WATER SUPPLY AUGMENTATION AND CONSERVATION

Includes the following Groups: Saline Water Conversion; Water Yield Improvement; Use of Water of Impaired Quality; Conservation in Domestic and Municipal Use; Conservation in Industry; Conservation in Agriculture.

04 WATER QUANTITY MANAGEMENT AND CONTROL

Includes the following Groups: Control of Water on the Surface; Groundwater Management; Effects on Water of Man's Nonwater Activities; Watershed Protection.

05 WATER QUALITY MANAGEMENT AND PROTECTION

Includes the following Groups: Identification of Pollutants; Sources of Pollution; Effects of Pollution; Waste Treatment Processes; Ultimate Disposal of Wastes; Water Treatment and Quality Alteration; Water Quality Control.

06 WATER RESOURCES PLANNING

Includes the following Groups: Techniques of Planning; Evaluation Process; Cost Allocation, Cost Sharing, Pricing/Repayment; Water Demand; Water Law and Institutions; Nonstructural Alternatives; Ecologic Impact of Water Development.

07 RESOURCES DATA

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08 ENGINEERING WORKS

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SELECTED WATER RESOURCES ABSTRACTS

2. WATER CYCLE

2A. General

METEOROLOGIC AND HYDROLOGIC DATA COLLECTED FOR COMPUTING EVAPORATION FROM DEVILS LAKE, NORTH DAKOTA, 1986-88.
Geological Survey, Bismarck, ND. Water Resources Div.
For primary bibliographic entry see Field 2D.
W91-07188

LIST OF TERMS OF HYDROGEOLOGY, GEOCHEMISTRY AND GEOTHERMALS OF MINERAL AND THERMAL WATERS.
International Association of Hydrogeologists, Paris (France).
For primary bibliographic entry see Field 10D.
W91-07195

WATER BALANCE OF A SANDY AQUIFER AT HYDRYLA IN SOUTHERN FINLAND.
For primary bibliographic entry see Field 2F.
W91-07196

U.S. GEOLOGICAL SURVEY FEDERAL-STATE COOPERATIVE WATER-RESOURCES PROGRAM, FISCAL YEAR 1989.
Geological Survey, Reston, VA.
For primary bibliographic entry see Field 7B.
W91-07210

RUNOFF AND PEAK DISCHARGES USING GREEN-AMPT INFILTRATION MODEL.
Soil Conservation Service, Bozeman, MT.
J. A. Van Mullem.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 117, No. 3, p 354-370, March 1991. 5 fig, 7 tab, 27 ref.

Descriptors: *Hydrologic models, *Infiltration, *Model studies, *Rainfall-runoff relationships, Flood peak, Hydrographs, Montana, Numerical analysis, Runoff rates, Runoff volume, Soil water, Watersheds, Wyoming.

The prediction of both the volume and rate of runoff from a watershed from a rainfall event is vital for a good design of hydraulic structures. Since the part of the rainfall that infiltrates into the soil is usually greater than the part that runs off, a good estimate of the runoff requires a good estimate of the infiltration. The Green-Ampt infiltration model was used to predict runoff from 12 rangeland and cropland watersheds in Montana and Wyoming. Soil parameters derived from data in standard USDA soil surveys were used, and 99 rainfall events were modeled. The runoff distributions obtained from the model were then used with a hydrograph model to predict the peak discharge from the watershed. Procedures were applied that adjusted the Green-Ampt infiltration parameters for various cover and condition classes. The model was applied to areas of up to 54 sq mi with a wide variety of soil and cover conditions. The runoff volumes and peak discharges were compared with the measured values and with those predicted by the Soil Conservation Service curve-number procedure. The Green-Ampt model predicted both the runoff volume and peak discharge better than the curve-number model. The standard error of estimate was less for the Green-Ampt model in nine of 12 watersheds for runoff volumes and in 11 of 12 watersheds for peak discharges. (Author's abstract)
W91-07593

DIGITAL TERRAIN MODELLING: A REVIEW OF HYDROLOGICAL, GEOMORPHOLOGICAL, AND BIOLOGICAL APPLICATIONS.
Australian National Univ., Canberra. Centre for Resource and Environmental Studies.
For primary bibliographic entry see Field 7C.
W91-07616

WATER IN THE UNIVERSE.
South Australian Dept. of Engineering and Water Supply, Adelaide.
V. Kotwicki.
Hydrological Sciences Journal HSJODN, Vol. 36, No. 1, p 49-66, February 1991. 5 tab, 68 ref.

Descriptors: *Atmospheric water, *Distribution patterns, *Hydrology, *Water properties, *Water resources, Condensation, Global precipitation, Hydrogen, Oxygen, Solar radiation, Water supply.

Water appears to be one of the most abundant molecules in the Universe. It dominates the environment of the Earth and is a main constituent of numerous planets, moons, and comets. On a far greater scale it possibly contributes to the so-called 'missing mass' of the Universe and may initiate the birth of stars inside the giant molecular clouds. The Earth, a 'water planet,' contains some 0.07% water by mass or 0.4% by volume. The origin of water on Earth is by no means certain and numerous mechanisms have been advocated. They fall into three theoretical categories: condensation of the primary atmosphere, outgassing of the interior, and extraterrestrial fallout. On the 'local' scale, water appears to be in sufficient quantities to satisfy any conceivable needs of the present and future inhabitants of the Solar System. From the whole mass of this cosmic entity, the amount of water in planets, moons, and comets is a formidable quantity; the estimated ratio of the mass of the Sun to the mass of all other objects in the Solar System to the mass of water is of the order of 20,000:20:1. As hydrogen is so plentiful in the Universe, the synthesis of water depends on the supply of oxygen, the third most abundant element in the Universe (between helium and neon). Trying to establish a temporal pattern of occurrence of water in the Universe requires some stretching of the imagination and a fair dose of conjecture. The vast majority of phenomena which are discussed in the Earth's hydrology are driven entirely by the Sun while the remainder have had a solar origin in recent or remote past. It is therefore conceivable that the understanding of astronomical events will add to our comprehension of hydrological phenomena on both global and local scales. (Fish-PTT)
W91-07627

1984 FLOODING OF MALHEUR-HARNEY LAKE, HARNEY COUNTY, SOUTHEASTERN OREGON.
Geological Survey, Portland, OR. Water Resources Div.
For primary bibliographic entry see Field 2H.
W91-07811

LOW FLOWS DURING THE 1988 DROUGHT IN TENNESSEE.
Geological Survey, Nashville, TN. Water Resources Div.
For primary bibliographic entry see Field 2E.
W91-07812

REGIONALIZATION IN HYDROLOGY.
Proceedings of an International Symposium held at Ljubljana, Yugoslavia, April 23-26, 1990. IAHS Publication No. 191. International Association of Hydrological Sciences, Washington, DC. 1990. 260p.

Descriptors: *Conferences, *Hydrologic models, *Hydrology, *Model studies, *Regional analysis, *Symposium, Basins, Catchment areas, Data acquisition, Hydrologic budget, Mathematical studies, Watersheds.

Regionalization is a scientifically and practically important subdivision of hydrological science. Two broad approaches are encompassed in the term 'regionalization': quantifying the components of the hydrological cycle at a regional scale, and establishing links between hydrological variables and the physiographic, climatic and land cover characteristics of the region. Papers presented at this conference was divided into three main topics: (1) data acquisition; (2) hydrological modeling; and (3) regional transfer modeling. Contributions to the first topic consist of those papers which are strongly observationally-based and which describe procedures for acquiring regional data or for field measurement of parameters used in regional models. The second topic uses a theme of a philosophical framework for regionalization, or concern with modeling problems in particular environments or applications. A general framework is provided for the third topic concerning prediction and hydrological estimation by the regional approach, followed by methodological papers and multiple linear regression applications. (See W91-07921 thru W91-07946) (Fish-PTT)
W91-07920

WATER AND HEAT EXCHANGE ON DIFFERENT TYPES OF LAND SURFACE ON THE NORTHERN SLOPE OF THE CENTRAL CAUCASUS.
Akademiya Nauk SSSR, Moscow. Inst. Geografii.
A. B. Shmakin, and M. D. Ananicheva.
IN: Regionalization in Hydrology. IAHS Publication No. 191. International Association of Hydrological Sciences, Washington, DC. 1990. p 69-79, 3 fig, 1 tab, 18 ref.

Descriptors: *Air-earth interfaces, *Heat budget, *Heat transfer, *Hydrologic models, *Mathematical models, *Model studies, *Mountains, Alpine regions, Energy, Net radiation, Radiation, Runoff forecasting, Terrain analysis.

Estimates of typical heat flux values from different height zones of a mountain massif into the atmosphere may be obtained with the aid of a mathematical net radiation model. A mathematical model of net radiation and heat balance in the mesoscale has been developed for investigation of heat and water exchange on mountain terrains, taking into account the most significant factors determining the balance of energy on the land surface. Some input parameters were taken from field measurements. Some conclusions were drawn about the role of different types of land surface in forming a boundary layer climate; rocks devoid of vegetation, alpine meadows and margin steppes give most of the sensible heat flux to the atmosphere, while forests and subalpine meadows give most of the latent heat flux. These results are close to the water balance data of the hydrometric network. Mountain relief ruggedness plays a role in the radiation balance; the net radiation average for the whole territory increases by 19% because of the multiple reflection and emission of radiation between slopes. The runoff for the snowmelt period was estimated by the net radiation model evaluation. Comparison of the runoffs calculated by the model and those measured at hydrometric stations showed a relative error of 2% and 47% at two stations. (See also W91-07920) (Author's abstract)
W91-07928

EFFECT OF REGIONAL CLIMATE CONDITIONS ON THE RAINFALL-RUNOFF PROCESS IN URBAN CATCHMENTS: THE CASE OF SNOWY SURFACES.
Belgrade Univ. (Yugoslavia). Faculty of Civil Engineering.
For primary bibliographic entry see Field 2C.
W91-07933

VARIATIONS IN HYDROCLIMATIC COMPONENTS AND THE CONCEPT OF REGIONALIZATION IN WEST AFRICA.
Lagos Univ. (Nigeria). Dept. of Geography.
For primary bibliographic entry see Field 2B.
W91-07935

2B. Precipitation

METEOROLOGIC AND HYDROLOGIC DATA COLLECTED FOR COMPUTING EVAPORATION FROM DEVILS LAKE, NORTH DAKOTA, 1986-88.
Geological Survey, Bismarck, ND. Water Resources Div.
For primary bibliographic entry see Field 2D.
W91-07188

Field 2—WATER CYCLE

Group 2B—Precipitation

UPDATES TO THE 1986 DIRECTORY OF PRECIPITATION MONITORING SITES NATIONAL ATMOSPHERIC DEPOSITION PROGRAM/NATIONAL TRENDS NETWORK (NADP/NTN).
Colorado State Univ., Fort Collins. Natural Resource Ecology Lab.
For primary bibliographic entry see Field 7B.
W91-07217

MARCHAL: A THREE-DIMENSIONAL MODEL FOR GROUNDWATER FLOW AND QUALITY MODELLING.
Strasbourg-1 Univ. (France). Inst. de Mechanique des Fluides.
P. Ackerer, R. Mose, M. Ruch, and K. Semra.
IN: ModelCARE 90: Calibration and Reliability in Groundwater Modelling. IAHS Publication No. 195. International Association of Hydrological Sciences, Washington, DC. 1990. p 127-134. 2 fig, 11 ref.

Descriptors: *Groundwater movement, *Groundwater quality, *Groundwater transport, *Hydrologic models, *Mass transport, *Model studies, *Path of pollutants, *Solute transport, Calibrations, Computer models, Data interpretation, Dispersion coefficient, Finite element method, Flow equations, Flow models, Mathematical analysis, Mathematical equations, Mathematical studies, Model testing, Stochastic process, Tracers.

Almost all groundwater flow modeling programs calculate the heads first and then the velocities as derivatives the heads. This evaluation of the flow field is not very accurate because of the approximations made of the heads due to the numerical techniques. A three-dimensional groundwater solute transport model (MARCHAL) was developed which combines the mixed hybrid finite element method for flow simulation and the stochastic particle tracking method for solute transport simulation. The main advantage of the method over the classical finite difference method or finite element method is that it is free of numerical dispersion. One of the disadvantages is that it requires a well calculated flow field in order to estimate correctly the derivatives of the dispersion coefficient. To validate the MARCHAL code, a simulation of a 3 dimensional tracer experiment was performed. The results of the simulation showed good agreement between measured and calculated concentrations. Due to the magnitude of the longitudinal dispersivity (i.e., 1 mm), classical methods will need about 40 million nodes to perform simulations without numerical dispersion. In three dimensions, for low dispersivity coefficient values or for large scale problems, only a particle tracking method can be used. (See also W91-07253) (Korn-PTT)
W91-07266

TEMPORAL VARIABILITY OF ATMOSPHERIC LEAD CONCENTRATIONS AND FLUXES OVER THE NORTHWESTERN MEDITERRANEAN SEA.
Paris-7 Univ. (France). Lab. de Physico-Chimie de l'Atmosphere.
For primary bibliographic entry see Field 5B.
W91-07396

REGIONAL NUMERICAL SULFUR DISPERSION MODEL USING A METEOROLOGICAL MODEL WITH EXPLICIT TREATMENT OF CLOUDS.
Bergen Univ. (Norway). Dept. of Meteorology.
E. Berge.
Tellus TELLAL, Vol. 42B, No. 5, p 389-407, 1990. 14 fig, 1 tab, 39 ref, append. Norwegian Research Council Grant D.41.12.029.

Descriptors: *Acid rain, *Chemistry of precipitation, *Dispersion, *Model studies, *Path of pollutants, *Sulfur, Advection, Cloud chemistry, Clouds, Condensation, Eddy diffusion, Europe, Mass balance, Mathematical models, Model testing, Oxidation, Precipitation, Simulation, Sulfates, Sulfur dioxide, Vertical distribution.

A regional numerical short-term (hours to days) sulfur dispersion model, interacting with a NWP-model with a detailed treatment of clouds and condensation, is formulated and tested. The model has 10 layers in the vertical, 50 km horizontal resolution, and covers NW Europe. It is initialized with model-simulated fields of sulfur dioxide and sulfate in air, based on realistic sulfur SO2 emission fields. A simple parameterization scheme for dry deposition, oxidation, uptake by clouds, and deposition by precipitation is applied. The numerical treatment ensures positive-definite and mass-conserving solutions. A comparison between a 36-h integration on a real synoptic situation and surface measurements suggests that the wet deposition of sulfate and the sulfate in air is underestimated over Scandinavia. SO2 in air is overestimated close to the sources. The simulations indicate that both the oxidation rate and the vertical transport by eddy diffusion are too low. The model has proven to be a basis for further research. In addition to the inclusion of gas and cloud phase chemistry, it would be meaningful with investigations of sensitivity to vertical transport, shape preserving advection routines, parameters of the condensation scheme, vertical distribution and horizontal resolution of the emission field. (Author's abstract)
W91-07402

FACTORS GOVERNING CLOUD WATER COMPOSITION IN THE APPALACHIAN MOUNTAINS.
Oregon State Univ., Corvallis. Dept. of Atmospheric Sciences.
R. J. Vong, B. H. Bailey, M. J. Markus, and V. A. Mohnen.
Tellus TELLAL, Vol. 42B, No. 5, p 435-453, 1990. 6 fig, 4 tab, 34 ref. U. S. EPA Cooperative Agreement CR815714-010.

Descriptors: *Acid rain, *Appalachian Mountains, *Chemistry of precipitation, *Cloud chemistry, *Cloud liquid water, *Clouds, *Meteorology, Aerosols, Ammonium, Analysis of variance, Annual distribution, Cyclones, Hydrogen ion concentration, Monitoring, Nitrates, Precipitation, Sulfates, Weather.

Cloud events collected during the summers of 1986-1988 at 5 sites in the Appalachian Mountains were classified on the basis of meteorology. The data consisted of cloud water chemical concentrations, liquid water content (LWC), mixed-layer air trajectories, synoptic type from weather maps, and whether or not the cloud was precipitating. An analysis of variance supported the hypothesis that the meteorological variables describe the cloud water chemical composition; there were differences between precipitating and nonprecipitating events (> few hours duration) and among synoptic-trajectory classes. The highest H(+), sulfate, ammonium, and nitrate concentrations occur when a site is in the warm sector of the cyclone or in a cap cloud; lower concentrations occur during easterly (marine) flow or post-cold-frontal cloud events. The difference among classes was similar when cloud LWC was accounted for; this supports the hypothesis that the synoptic-trajectory classes describe differences in the transport and mixing of aerosol and gases rather than LWC differences. The chemical concentrations for non-monitored cloudy hours were predicted from the meteorological classes and the resulting mean concentrations for the entire growing season were compared to the sampled cloud events. Insufficient data exist for examining annual variability, but, when all 3 years of data were used together, differences between sampling sites could be observed. (Author's abstract)
W91-07403

STRONG SIMILARITIES IN SEASONAL CONCENTRATION RATIOS OF SO4(2-), NO3(-) AND NH4(+) IN PRECIPITATION BETWEEN SWEDEN AND THE NORTHEASTERN US.
New York Botanical Garden, Bronx, NY. Inst. of Ecosystem Studies.
For primary bibliographic entry see Field 5B.
W91-07404

EVALUATION OF DRY DEPOSITION, POLLUTANT DAMAGE, AND FOREST HEALTH WITH THROUGHFALL STUDIES.
Smithsonian Environmental Research Center, Edgewater, MD.
For primary bibliographic entry see Field 5C.
W91-07467

REFLECTIONS ON THE USE OF LONG SERIES OF CLIMATOLOGICAL OBSERVATIONS AS PART OF THE STUDY CLIMATE AND ITS CHANGES (REFLEXIONS SUR L'UTILISATION DES LONGUES SERIES D'OBERVATIONS CLIMATOLOGIQUES DANS LE CADRE DE L'ETUDE DU CLIMAT ET DE SON EVOLUTION).
Electricite de France, Grenoble. Div. Technique.
D. Duband.
Houille Blanche HOBLAB, Vol. 1990, No. 6, p 399-407, 1990, 26 fig, 13 ref. English summary.

Descriptors: *Climatic changes, *Climatic data, *Climatology, *Data interpretation, *Global warming, Data quality control, France, History, Switzerland, Time series analysis.

Information on climate change must remain objective, if it is to remain creditable. It is important to appreciate the quality of historical climatic data, and to appreciate the fluctuation in extremes, means and frequencies which are possible in a stable climate. These fluctuations can appear in long series of daily, monthly and annual data, and also affect the proper evaluation of specially-collected data. It is important to control or reconstruct missing data in order to ensure validity. This is necessary to control effects due to movement of the measurement station, effects of modification of measurement procedure, and effects of urbanization on the station measurements. Air temperature data evaluated for the towns of Bale, Geneve, Clermont-Ferrand, and Pau shows no tendency for warming for the past 250 years. There are historical examples of droughts and cold waves and large climatic modifications including the warm spell which appeared in the 9th through 13th centuries and a little ice age which appeared in 16th through 18th centuries. The author urges caution with historical data. (King-PTT)
W91-07528

EFFECT OF CUMULATIVE EROSION AND RAINFALL ON SORGHUM, PEARL MILLET AND CASTOR BEAN YIELDS UNDER DRY FARMING CONDITIONS IN ANDHRA PRADESH, INDIA.
Central Research Inst. for Dryland Agriculture, Hyderabad (India).
For primary bibliographic entry see Field 2I.
W91-07569

INTRASEASONAL (30-50 DAY) OSCILLATION OF THE AUSTRALIAN SUMMER MONSOON.
Colorado Univ. at Boulder. Center for Atmospheric Theory and Analysis.
H. H. Hendon, and B. Liebmann.
Journal of the Atmospheric Sciences JAHSAK, Vol. 47, No. 24, p 2909-2923, December 15, 1990. 13 fig, 1 tab, 21 ref.

Descriptors: *Australia, *Climatology, *Meteorology, *Monsoons, *Tropical regions, *Wind, Air temperature, Atmospheric circulation, Convection, Oscillatory waves, Rainfall.

The tropical intraseasonal (30-50 day) oscillation manifests itself in the Australian summer monsoon by a pronounced modulation of the monsoonal westerlies. These fluctuations of the monsoonal westerlies are coherent with rainfall and outgoing longwave radiation OLR across northern Australia. The detailed evolution of the intraseasonal oscillation of the monsoon was studied via composites of upper air data in and about the Australian tropics. During the summer periods 1957-87, 91 events were identified at Darwin, Australia. The composite oscillation at Darwin has a very deep baroclinic structure with westerlies extending up to 300 mb. The westerly phase lasts about ten days and lags a similar duration rainfall event by about four days. During the westerly phase, the upper troposphere is warm and the extreme lower

troposphere is cool. This structure is consistent with midtropospheric latent heating and lower tropospheric cooling due to evaporation of falling rain. The magnitude of the composite oscillation at Darwin is about 5 m/s in zonal wind, 1 m/s in meridional wind, 0.5 K in temperature, 5 mm rainfall per day, and 10% in relative humidity. The oscillation at Darwin is readily traced as far west as Cocos Island and as far east as Pago Pago. Above northern Australia, enhanced synoptic scale variability develops during the wet-westerly phase of the oscillation. Analysis of a single station record precludes documentation of the structure of these synoptic fluctuations. In the Northern Hemisphere midlatitudes, a wave train in 500 mb heights appears to emanate from the longitude of the Australian tropics during the wet-westerly phase. The magnitude of this wave train is only about 50 m while the wave train undergoes a systematic evolution as the tropical convective anomaly moves west to east, no sense of dispersion from a localized low-latitude heat source is evident. (Author's abstract)
W91-07609

EVOLUTION OF THREE-PEAK RAINDROP SIZE DISTRIBUTIONS IN ONE-DIMENSIONAL SHAFT MODELS: PART I. SINGLE-PULSE RAIN.
Toronto Univ. (Ontario). Dept. of Physics.
R. List, and G. M. McFarquhar.
Journal of the Atmospheric Sciences JAHSAK, Vol. 47, No. 24, p 2996-3006, December 15, 1990. 6 fig, 1 tab, 30 ref.

Descriptors: *Drop size, *Fluid drops, *Model studies, *Rain, *Raindrop size, Mathematical models, Numerical analysis, Rainfall.

Several warm rain modeling studies have investigated the time evolution of drop-size distributions. A model has been developed to describe the temporal evolution of drop size distributions in warm one-dimensional rain shafts which includes the sedimentation of drops with the collisional breakup and coalescence of raindrops. A numerical simulation of the interactions of raindrops in one-dimensional rain shafts with still air was used to calculate the changes in number concentration of different size drops during coalescence and collision-induced breakup and the fall of drops. It was found that pulsed input of raindrop packages at the top of one-dimensional shafts, followed by coalescence and breakup during the fall, produces, when integrated over time of the whole rainfall, three-peak drop-size distributions (3PDs) at all levels throughout the shaft. The 3PDs are different from the three-peak equilibrium distributions (3PEDs) that develop with steady sources of rain. However, for long pulse lengths, the 3PD becomes closer to the 3PEDs; for short pulse lengths, the large-drop peak is not very prominent for the input of Marshall-Palmer distributions. The diameters corresponding to the maximum concentrations are approximately the same as those of the 3PED. For 3PED input, the biggest differences between the number concentrations for the 3PED and 3PDs occur for pulse lengths between 240 and 600 s while the radar reflectivity concentrations of 3PDs steadily approach that of 3PEDs with increasing pulse length. All trends are the same whether a 3PED or a Marshall-Palmer distribution is used as input. (Fish-PTT)
W91-07610

RADAR OBSERVATIONS OF THE HALIFAX STORM, 19 MAY 1989.
Lancaster Univ. (England). Inst. of Environmental and Biological Sciences.
V. K. Collinge, E. J. Archibald, K. R. Brown, and M. E. Lord.
Weather WTHRAL, Vol. 45, No. 10, p 354-365, 1990. 7 fig, 1 tab, 14 ref.

Descriptors: *England, *Meteorological data, *Radar, *Rain gages, *Storms, *Weather data collections, Climatic data, Meteorological data collection, Precipitation, Rainfall, Thunderstorms.

Severe atmospheric instability over northern England on 19 May 1989 led to the development of an exceptionally severe thunderstorm over an area of the Pennines between Burnley and Halifax. This storm was so close to the Hameldon Hill weather radar, near Burnley, that the observations from that site are of particular interest. The performance of the radar in detecting the intensity and movement of this storm was compared to rain gage data. It was found that the radar data gave an accurate indication of the area and timing of heavy rainfall with good correspondence to the areas of flood damage. In some places where the radar indicated a storm rainfall total of up to 14 mm, little or none fell on the ground. This was partly due to low-level evaporation, and partly as a consequence of the severe rainfall gradients near the periphery of the storm. Overall, the agreement between 22 rain gage storm totals and the corresponding radar rainfall totals for the nearest 2 km x 2 km pixel was good, judged on a logarithmic transformation of assessment factor (AF) values. This yielded a nearly normal distribution with a mean logarithmic value equivalent to an AF of 1.17. Of the 22 AF values, 20 were in the range 0.55-2.78. The radar substantially underestimated the rainfall at the two sites with the highest rain gage totals, possibly as a consequence of insplash. Analysis of all the available data indicates the possibility that beam height is involved in the relationship between rain gage and radar observations. It was concluded that weather radars have considerable potential for forecasting the movement of storms of this type. (Fish-PTT)
W91-07611

URBAN OROGRAPHIC RAINFALL ANOMALY IN JERUSALEM--A NUMERICAL STUDY.
Tel-Aviv Univ. (Israel). Dept. of Geophysics and Planetary Sciences.
H. Shafir, and P. Alpert.
Atmospheric Environment Part B: Urban Atmosphere AEBAE5, Vol. 24, No. 3, p 365-375, 1990. 7 fig, 10 tab, 39 ref. BSF Grant No. 8600230.

Descriptors: *Israel, *Jerusalem, *Local precipitation, *Meteorology, *Model studies, *Orographic precipitation, *Urban areas, *Urban hydrology, Cloud liquid water, Condensation, Heat transfer, Numerical analysis, Orography, Rainfall disposition.

The urban effect on precipitation is very difficult to determine because only a few rural regions remain undisturbed from their natural states, because there is an insufficient number of raingages in metropolitan areas, and because many cities are associated with bodies of water or hilly terrain which can effect precipitation patterns on their own. An orographic (physical) model was applied to a hilly domain in central Israel in an attempt to separate quantitatively urban precipitation effects over highly complex terrain. A high-resolution meso-gamma scale indexing of the orographic precipitation over the Judean Mountains suggests a positive urban precipitation anomaly in Jerusalem. The urban rainfall enhancement for three rainfall events was found to be 20-30% as compared to only about 10% for the annual normals. In general it appears that urban orographic increases were high. A possible explanation for this is the supply of great amounts of cloud condensation nuclei (CCN) to the orographic feeder clouds which are strongly dependent on CCN. For cold rain events the urban contribution may even be greater as a result of the higher artificial energy used which, in turn, causes greater CCN emissions and an enhanced 'heat island' effect. In order to further investigate this phenomenon, such models must be used in other orographic urban regions and must incorporate techniques for sampling the raindrops. In addition, three-dimensional microphysical orographic models must be used to realistically simulate the microphysical effects including the CCN contribution to precipitation in orographic urban areas. (Fish-PTT)
W91-07612

COMPARISON OF URBAN AND SUBURBAN PRECIPITATION CHEMISTRY.
Argonne National Lab., IL. Environmental Research Div.
D. L. Sisterson, and J. D. Shannon.
Atmospheric Environment Part B: Urban Atmosphere AEBAE5, Vol. 24, No. 3, p 389-394, 1990. 4 tab, 19 ref.Office of Health and Environmental Research of the U.S. Department of Energy Contract W-31-109-ENG-38.

Descriptors: *Acid rain, *Chemistry of precipitation, *Chicago, *Suburban areas, *Urban areas, *Water chemistry, *Water pollution sources, Acid rain effects, Air pollution effects, Ammonia, Calcium, Chlorine, Hydrogen, Magnesium, Nitrates, Sodium, Sulfates, Wind.

There is a pressing need for information on the chemical composition of urban precipitation, because buildings and monuments potentially at risk to damage from acid rain are concentrated in urban areas. Precipitation samples at an urban Chicago site and a nearby suburban site were compared in order to examine the influence of emissions within a large urban area on local precipitation chemistry. Precipitation samples were collected from June 1981 to May 1982, initially for events and subsequently weekly, and precipitation-weighted concentrations (PWCs) of the major chemical constituents were calculated from concurrent urban-suburban pairs of samples, stratified according to the estimated mixed-layer wind quadrant. Overall, PWCs at the urban site were higher than those at the suburban site for Ca(+2), Mg(+2), NH4(+), NO3(-), and Cl(-); approximately equal for Na(+) and SO4(-2); and lower for H(+). For precipitation in southwesterly flow, in which the suburban site was upwind of the urban site and most urban emissions, PWCs of all species except Na(+) were higher at the urban site. For the few precipitation cases in northeasterly flow, however, differences between sites did not have a pattern consistent with a reversal in the upwind-downwind relationship. (Author's abstract)
W91-07613

MEASUREMENT OF ATMOSPHERIC WATER VAPOR: RADIOMETER COMPARISON AND SPATIAL VARIATIONS.
Cooperative Inst. for Research in Environmental Science, Boulder, CO.
C. Rocken, J. M. Johnson, R. E. Neilan, M. Cerezo, and J. R. Jordan.
IEEE Transactions on Geoscience and Remote Sensing IGRSD2, Vol. 29, No. 1, p 3-8, January 1991. 4 fig, 2 tab, 24 ref.

Descriptors: *Atmospheric water, *Instrumentation, *Measuring instruments, *Meteorologic data collection, *Meteorology, *Radiometry, *Remote sensing, Analytical methods, Colorado, Interferometry, Precipitation, Satellite technology, Spatial distribution, Water vapor.

While the use of surface meteorological measurements does not, in general, provide zenith tropospheric corrections of sufficient accuracy, these corrections can be estimated as parameters during the Global Positioning System (GPS) and Very Long Baseline Interferometry (VLBI) data inversion. Such computed zenith corrections can accurately account for the temporal changes of the zenith delay, but do not account for spatial variations. These variations can be directly measured with water vapor radiometers (WVRs). Two WVR experiments were conducted to evaluate whether such instruments are both suitable and needed to correct for propagation effects that are induced by precipitable water vapor (PWV) on signals from the GPS and VLBI. WVRs are suitable for these corrections if they provide wet path delays to better than 0.5 cm. In the first experiment, six WVRs were compared at Stapleton International Airport in Denver, Colorado, for two weeks. While two WVRs showed an average wet path delay bias of only 0.1 cm, other were biased by 1-3 cm relative to each other and relative to radiosondes. The second experiment addressed the question whether radiometers are needed for the detection of inhomogeneities in the wet delay. Three JPL D-series radiometers were operated at three sites in Colorado approximately 50 km apart. The WVRs simultaneously sampled PWV at different azimuths and elevations in search of spatial variations of PWV. On one day of this second

experiment evidence was found for spatial variations of the wet path delay as high as 20% of the total wet path delay. Based on the observed biases, it is recommended that radiometers of similar design be used. (Fish-PTT)
W91-07614

MODIFIED METHOD FOR DROUGHT IDENTIFICATION.
Indian Inst. of Tech., Madras. Dept. of Civil Engineering.
For primary bibliographic entry see Field 3F.
W91-07624

VARIATION IN RAINFALL CATCH FROM STANDARD UK METEOROLOGICAL OFFICE RAINGAUGES: A TWELVE YEAR CASE STUDY.
Liverpool Univ. (England). Dept. of Geography.
For primary bibliographic entry see Field 7B.
W91-07625

INFLUENCE OF TROPICAL CYCLONES AS SOIL ERODING AND SEDIMENT TRANSPORTING EVENTS. AN EXAMPLE FROM THE PHILIPPINES.
Hydraulics Research Ltd., Wallingford (England).
For primary bibliographic entry see Field 2J.
W91-07739

AGROCLIMATOLOGY OF SEMIARID LANDS.
National Soil Tilth Lab., Ames, IA.
For primary bibliographic entry see Field 3F.
W91-07754

CAUSES AND OCCURRENCE OF DROUGHT.
California Univ., Los Angeles. Dept. of Civil Engineering.
J. A. Dracup.
IN: Drought Management and Its Impact on Public Water Systems. National Academy Press, Washington, DC. 1986. p 24-48. 9 fig, 42 ref.

Descriptors: *California, *Climatology, *Drought, *Drought effects, *Forecasting, *Irrigation water, *Model studies, *Water management, *Weather forecasting, *Western United States, Meteorological data collection, Streamflow forecasting, Water allocation, Water demand, Water supply, Water use.

The statistical, synoptic, and physical aspects of drought on time scales of a month to several years in temperate latitudes are considered. The current literature reveals that the causes of drought are complex and are not yet completely understood by meteorologists and climatologists. High-pressure cells exist over drought-affected regions and companion oceanic high-pressure areas exist simultaneously. During drought periods there is a general northward shifting of pressure zones. The westerlies are displaced northward over the continental United States during droughts, bringing stronger than normal winds to the high latitudes. Once the high-pressure cells are formed and the drought is initiated, there is a self-perpetuating mechanism that continues the process. A scientific forecast of a geophysical event such as a drought must include the event's time of occurrence and its magnitude, duration and location. Meteorological methods of drought forecasting include analogues, linear regression models, teleconnections, statistical and kinematic models, air-sea interactions, statistical time series forecasts and extrapolation in time using cyclicities. Current meteorological forecasts are made by the Scripps Institute of Oceanography in California. The forecasts provide the California State Department of Water Resources with the information to manage reservoirs throughout California mainly for irrigation supply deliveries. The National Weather Service and the Soil Conservation Service jointly publish monthly reports on the Water Supply Outlook for the Western United States. The meteorologic and hydrologic forecasts are principally used to allocate irrigation water supplies to senior and junior irrigation districts with appropriative rights in California and throughout the West. The Namias method for evaluating the skill of forecasting drought is used to assess drought forecast accuracy. The determination of streamflow forecast accuracy is more difficult in that the measured streamflow has to be converted to unimpaired flows. Erroneous forecasts by the U.S. government have resulted in poor planning by farmers and lawsuits against the government for revenues lost by miscalculations in water allocations. (See also W91-07794) (Geiger-PTT)
W91-07796

ORGANIC COMPOUNDS IN PRECIPITATION.
Fraunhofer-Inst. fuer Toxikologie und Aerosolforschung, Hanover (Germany, F.R.).
K. Levsen, S. Behnert, B. Prieb, M. Svoboda, and H.-D. Winkeler.
Chemosphere CMSHAF, Vol. 21, No. 9, p 1037-1061, 1990. 7 fig, 1 tab, 51 ref.

Descriptors: *Chemical analysis, *Organic compounds, *Pollutant identification, *Polycyclic aromatic hydrocarbons, *Precipitation, *Water pollution sources, Fatty acids, Germany, Literature review, Phenols, Precipitation scavenging, Sample preparation, Seasonal variation, Water quality standards.

The contamination of precipitation by organic compounds was investigated for rain, snow, and hail samples collected in Hannover, Germany between the years 1988 and 1990. Precipitation samples were analyzed for n-alkanes, fatty acids, n-alkanols, aldehydes, phenols, and polycyclic aromatic hydrocarbons (PAHs). Overall, while the values obtained in the investigation for most organic compounds were in the same range as those reported in the literature, n-alkane concentrations were much higher than those values previously published. In addition, concentrations appeared to vary substantially from one rain event to another and a significant seasonal dependence was observed for n-alkanes and PAHs. Surprisingly high average concentrations (> or = 10 micrograms/L) were observed for all compound classes studied, with the exception of the PAHs. In fact, the remarkably high concentrations of organic compounds in precipitation exceeded German drinking water standards. However, while the average concentration of all PAHs fell below the micrograms/l range, some samples exceeded the drinking water regulation concentration by a factor of 5. (Korn-PTT)
W91-07844

SIMULATION OF THE SIZE DISTRIBUTION AND EROSIVITY OF RAINDROPS AND THROUGHFALL DROPS.
Silsoe Coll. (England).
C. J. Brandt.
Earth Surface Processes and Landforms ESPLDB, Vol. 15, No. 8, p 687-698, December 1990. 6 fig, 3 tab, 29 ref. AFRC Research Grant No. AG63-189.

Descriptors: *Erosion, *Model studies, *Precipitation, *Rain, *Simulation analysis, *Soil erosion, *Throughfall, Canopy, Data interpretation, Fall velocity, Fluid drops, Rainfall intensity, Sensitivity analysis, Soil surfaces.

Soil splash, changes in surface roughness, and crust development are all important processes in soil erosion and are all caused by water drops impacting onto the soil surface. A model was developed that calculates the size distribution and impact velocity of rainfall and intercepted throughfall for use as inputs to the roughness change, splash detachment, and infiltration models. Sensitivity analysis reveals that the model is sensitive to parameters that are easily measured or estimated: rainfall intensity, the mean volume drop diameter of the intercepted throughfall, canopy cover, and canopy height. The model utilizes existing models of rainfall drop size distribution and fall velocity, and combines them with newly collated evidence of throughfall drop size distribution to provide a model that may be used at two levels. The model provides the specific information on both rainfall and throughfall drop size and impact velocity for use in physically-based soil surface models. More broadly, the model may be used to calculate erosivity indices, based on rainfall intensity, which take into account the transformation of rainfall drop size and fall velocities by a canopy. (Korn-PTT)
W91-07849

VARIATIONS IN HYDROCLIMATIC COMPONENTS AND THE CONCEPT OF REGIONALIZATION IN WEST AFRICA.
Lagos Univ. (Nigeria). Dept. of Geography.
O. Ojo.
IN: Regionalization in Hydrology. IAHS Publication No. 191. International Association of Hydrological Sciences, Washington, DC. 1990. p 147-156, 1 fig, 15 ref.

Descriptors: *Climatology, *Developing countries, *Hydrology, *Interdisciplinary studies, *Regional analysis, *West Africa, Climatic data, Hydrologic data, Microclimatology, Regional planning, Research priorities.

In recent years in West Africa, hydrological regions are sometimes selected or delineated by using hydroclimatic characteristics and/or other physical characteristics of the area concerned. Some climatological and hydroclimatological events were examined in West Africa for the period 1969-1987 in relation to macro, meso, and micro factors and within the concept of regionalization and its application to hydrological studies. The results show a lot of regional, intraregional, and locational variations in the characteristics of the hydrological and hydroclimatic components. The results also show that there is a limit to the representativeness of many of the data and information currently available for West Africa, and that the validity of many of the currently available empirically-determined data is considerably limited particularly for the purpose of applications of these data for research, planning, and development. There is an emphasized need for (1) adequate and reliable data and information, (2) efforts to coordinate the solution of problems of data and/or any other problems connected with the application of regionalization in the region, and (3) adequate considerations of the objectives of any research or planning programs for which the application of the concept of regionalization is needed. (See also W91-07920) (Fish-PTT)
W91-07935

RAINFALL-RUNOFF MODEL FOR SMALL UNGAUGED WATERSHEDS IN POLAND.
Institute of Meteorology and Water Management, Warsaw (Poland).
J. Ostrowski.
IN: Regionalization in Hydrology. IAHS Publication No. 191. International Association of Hydrological Sciences, Washington, DC. 1990. p 203-210, 1 fig, 3 tab, 6 ref.

Descriptors: *Hydrologic models, *Model studies, *Poland, *Rainfall-runoff relationships, *Regional analysis, *Small watersheds, *Ungaged basins, Flood hydrographs, Flood peak, Flow characteristics, Parametric hydrology, Storm runoff.

Research was carried out in Warsaw, Poland, to evaluate peak storm runoff and rainstorm flood hydrograph simulation for ungaged catchments up to 250 sq km by the Small Watershed Regional Model (SWRM). The rainfall hyetograph (1-h time step or multiple of hours) and 16 characteristics of the catchments are needed as input data to the SWRM. Values of the characteristics concerning basin area, river network, and Horton's ratios, as well as land use and vegetation cover, are determined from hydrographical or topographic maps. Model parameters include accumulated rainfall excess, accumulated storm rainfall, maximum potential difference between storm rainfall and direct runoff, curve number, total storm rainfall, watershed initial conditions, rainfall excess, soil profile feeding, interception storage, dynamic groundwater flow component, time-invariant groundwater baseflow component, soil moisture content, groundwater feeding, direct runoff, groundwater flow, flood duration, reservoir storage time, reservoir shape, main stream length, mean flood stream-

flow velocity, basin area, and rainfall excess duration time. The SWRM is stationary for floods because the time scale parameter depends on the lag time as well as on streamflow velocity, which both vary for every flood event. The watershed is treated as a lumped parameter system. Field studies for the Small Watersheds Project have been carried out on a network of 46 small Polish basins (areas from 2.8 to 231.6 sq km). The data from 192 floods in a five-year period (1981-1985) from 16 catchments were used in the regionalization. Preliminary results of model verification on quasi-independent and independent datasets are highly promising for future development of the model. (See also W91-07920) (Fish-PTT)
W91-07941

REGIONALIZATION OF PARAMETERS USING BASIN GEOLOGY, LAND USE, AND SOIL TYPE FOR USE IN A STORM RAINFALL-RUNOFF RELATIONSHIP.
Tokyo Metropolitan Univ. (Japan). Dept. of Civil Engineering.
Y. Ando.
IN: Regionalization in Hydrology. IAHS Publication No. 191. International Association of Hydrological Sciences, Washington, DC. 1990. p 211-218, 5 fig, 3 tab, 2 ref.

Descriptors: *Effective precipitation, *Japan, *Mathematical models, *Mountain watersheds, *Rainfall-runoff relationships, *Regional analysis, *Storm runoff, Base runoff, Geological data, Land use, Runoff rates, Soil types.

The storm rainfall-runoff relationship is important in estimating effective rainfall for runoff analysis. A regional analysis was performed using basin geology, land use, and soil type for use in a storm rainfall-runoff relationship. The study covers 31 mountainous basins in Japan. The storm rainfall-runoff relationship is expressed as functions of storm rainfall (mm), base runoff rate, the first critical rainfall depth (mm), and the first additional runoff rate. It was shown that the base runoff rate is equivalent to the ratio of saturated area to the catchment area, and that the first critical rainfall depth is about 55 mm, varying with basin geology. The total runoff rate (sum of the base runoff rate and first additional runoff rate) was analyzed statistically with basin geology and soil type. Multiple regression analysis was performed on the total runoff rate, in which the total runoff rate was the dependent variable and ratios of different soil covers to the catchment area were independent variables for each basin geology. (See also W91-07920) (Author's abstract)
W91-07942

IMPACT OF EL NINO 1982 /EVENT ON THE PARANA RIVER, ITS DISCHARGE AND TRANSPORT.
Universidad Nacional de Cordoba (Argentina). Dept. de Quimica.
For primary bibliographic entry see Field 2E.
W91-08108

CONTRIBUTION OF SULFATE TO RAINFALL PH AROUND KILAUEA VOLCANO, HAWAII.
Hawaii Univ. at Manoa, Honolulu. Dept. of Environmental Health Sciences.
For primary bibliographic entry see Field 5B.
W91-08115

WET DEPOSITION TRENDS OF MAJOR INORGANIC IONS IN FINLAND BASED ON DAILY BULK DEPOSITION SAMPLES.
Finnish Meteorological Inst., Helsinki. Air Quality Dept.
For primary bibliographic entry see Field 5B.
W91-08120

COMPARISON OF BULK AND WET-ONLY PRECIPITATION COLLECTORS AT RURAL SITES IN THE UNITED KINGDOM.
Warren Spring Lab., Stevenage (England).
J. R. Stedman, C. J. Heyes, and J. G. Irwin.
Water, Air and Soil Pollution WAPLAC, Vol. 52, No. 3/4, p 377-395, 1990, 7 fig, 4 tab, 23 ref. United Kingdom Department of the Environment, contract no. PECD/7/10/29.

Descriptors: *Analytical methods, *England, *Rain gages, Acid rain, Atmospheric chemistry, Chemistry of precipitation, Comparison studies, Ireland, Rainfall, Scotland.

Co-located wet-only and bulk precipitation collectors have been used to measure precipitation amount and ionic composition at nine rural sites in the United Kingdom. The wet-only collector collects less rain, particularly at more exposed, windier sites. This is believed to arise primarily from aerodynamic blockage rather than from late opening of the collector at the onset of rain. In general, agreement between the two types of collector for ionic composition is good. However, at two sites which experience low rainfall concentrations of primary and secondary pollutants in easterly airflow, the bulk collector yields larger concentrations of non-marine sulfate. Measurements of particulate sulfate suggest that dry deposition of particles is sufficient to explain the observed differences. In contrast, larger ammonium concentrations are measured with the wet-only collector. The observations are consistent with loss of ammonium from the bulk collector, particularly at sites of low annual mean acidity. These differences are greater in summer than in winter suggesting a biological loss mechanism. (Author's abstract)
W91-08124

2C. Snow, Ice, and Frost

SNOWPACK STORAGE OF POLLUTANTS, RELEASE DURING MELTING, AND IMPACT ON RECEIVING WATERS.
National Water Research Inst., Burlington (Ontario). Rivers Research Branch.
For primary bibliographic entry see Field 5B.
W91-07231

ICE JAM MITIGATION.
Cumming Cockburn Ltd., Willowdale (Ontario). Water Resources Div.
H. S. Belore, B. C . Burrell, and S. Beltaos.
Canadian Journal of Civil Engineering CJCEB8, Vol. 17, No. 5, p 675-685, October 1990, 6 fig, 1 tab, 37 ref.

Descriptors: *Canada, *Flood control, *Ice breakup, *Ice jams, *River ice, *River management, Flood damage, Flood forecasting, Flood plain management, Floodproofing, Flow control, Water resources management.

Flooding due to ice jams has resulted in the loss of life and extensive economic losses in Canada. The flooding is due to the rise in water levels upstream of an ice jam, or the temporary excedance of the flow and ice-carrying capacity of a channel upon release of an ice jam. Ice jam mitigation is a component of river ice management which includes all activities carried out to prevent removal of ice jams. or to reduce the damages that may result from an ice jam event and includes not only physical means of weakening, controlling, or breaking river ice, but aspects of water resource management as well. Ice jam mitigation techniques can be divided into: (1) ice jam prevention; (2) reduction of ice jam effects; and (3) ice jam removal and breaching. Prevention includes fixed structures, ice booms, channel modification, ice suppression, thermal regime modification flow regime modification, and icebreakers. Means of reducing the effects of ice jam floods include flow control works, flood control works, flood proofing, flood plain management, and flood forecasting and warnings. Means of ice jam removal and breaching include use of explosives, ice breakers, and mechanical ice jam removal. (King-PTT)
W91-07522

TEMPORAL AND SPATIAL SCALES OF ICE EDGE THERMODYNAMICS.
Geological Survey, Tacoma, WA. Water Resources Div.
E. G. Josberger.
IN: Regional and Mesoscale Modeling of Ice Covered Oceans. The Nansen Remote Sensing Center Conference Report No. 3, (1989). p 143-147, 1 fig, 4 ref.

Descriptors: *Bering Sea, *Ice cover, *Ice-water interfaces, *Spatial variation, *Temporal variation, *Thermodynamics, Ablation, Advection, Greenland Sea, Ice breakup, Mathematical analysis, Mathematical equations, Ocean circulation, Upwelling, Water circulation.

In the marginal ice zone, rapid ice melting strongly constrains the ice edge position and its rate of advance. This basically small-scale process occurs as a result of a variety of processes with different length and time scales. These processes include, but are not limited to, the wind drive advection of ice into warm off-ice water, the horizontal advection of heat beneath the ice by the regional and mesoscale oceanic circulation, and the vertical advection of heat by ice edge upwelling and eddy circulation. The Greenland Sea marginal ice zone, a complex system, contains all of these processes, but the primary controlling factor is the polar front that approximately parallels the ice edge and separates the cold polar Greenland Sea water from the more temperate water in the West Spitzbergen Current. The ice drift is nearly parallel to this front and ice edge and melting occurs when ice crosses this front as a result of large-scale wind events. The Bering Sea is a much simpler case; an ice conveyor belt where ice is formed in the north, the wind drives it south where it melts at the ice edge. For both the Greenland Sea and the Bering Sea, the primary agent for limiting ice edge advances is the warm upper ocean off the ice edge. Measurements for both seas, show that bottom ablation rates can reach 0.5 m/day/L, and the heat transfer coefficients range from 4,000 to 8,000. This simple analysis defines the temporal and spatial scales associated with ice ocean thermodynamic interactions. The resulting length scales are on the same order as many mesoscale processes that occur in the polar oceans. Hence, the interaction of thermodynamic and mesoscale processes are important in the heat and mass budget of ice covered oceans, especially in the Greenland Sea. Furthermore, now that the gridscales of numerical ice ocean models are approaching 25 km, the thermodynamic length scale, it is imperative that thermodynamic processes be properly included to achieve a realistic model. (Lantz-PTT)
W91-07918

PHYSICALLY-BASED SNOW-COVER MODEL.
National Board of Waters, Helsinki (Finland). Water Research Inst.
B. Vehvilainen.
IN: Regionalization in Hydrology. IAHS Publication No. 191. International Association of Hydrological Sciences, Washington, DC. 1990. p 117-126, 2 fig, 1 tab, 13 ref.

Descriptors: *Finland, *Hydrologic models, *Model studies, *Snow accumulation, *Snow cover, *Snowmelt, Evaporation, Freezing, Model testing, Precipitation, River basins, Thawing.

A physically-based snow-cover model has been developed for simulation of snow accumulation and snowmelt, and can be used for operational purposes in large river basins with minimum input data on a daily basis. Model inputs are precipitation, evaporation from the snow cover, and melting/freezing potential as simulated by an energy-balance model. Snow is divided into three phases: air, water, and ice. The processes which change the concentrations of different snow phases are precipitation, snow evaporation, melting/freezing, snow compaction, and release of water. The physically-based model should be better than the common degree-day snow models used normally in operational catchment hydrology, but this criterion has not yet been achieved with this or any other physical snow-cover model. However, this model gives much information on the different processes in snow accumulation and snowmelt phenomena, which can be useful in developing simpler snow models. This model was tested for

the Loimijoki basin in southern Finland. (See also W91-07920) (Fish-PTT)
W91-07932

EFFECT OF REGIONAL CLIMATE CONDITIONS ON THE RAINFALL-RUNOFF PROCESS IN URBAN CATCHMENTS: THE CASE OF SNOWY SURFACES.
Belgrade Univ. (Yugoslavia). Faculty of Civil Engineering.
C. Maksimovic, and S. T. Thorolfsson.
IN: Regionalization in Hydrology. IAHS Publication No. 191. International Association of Hydrological Sciences, Washington, DC. 1990. p 127-134, 4 fig, 4 ref.

Descriptors: *Climatic effects, *Hydrologic models, *Model studies, *Rainfall-runoff relationships, *Snow cover, *Urban hydrology, *Urban runoff, Frozen ground, Ice cover, Infiltration, Mass balance, Momentum equation, Norway, Sewer systems, Snow, Snowpack, Surface flow, Surface runoff.

The physical processes which affect rainfall-runoff modeling are different for climates which are different from those for which most modern modeling software has been developed. For reliable modeling of surface runoff it is necessary to take into consideration the physical processes relevant in the liquid-solid (water-snow) interaction. Snowy areas subjected to heavy storms were taken as an example, and the runoff in the coastal zones of Norway was analyzed to compare its components for a cold climate with those for a temperate climate. Depending on the combination of snow-air-temperature and moisture content, different types of two-phase flow will occur during a storm event over snow-covered soil: the highest runoff coefficient is generated when the snow cover is frozen; when the top of the snow cover is not frozen, rain quickly infiltrates into the snow layer until it becomes fully saturated; when there is neither ice interface nor ice cover on top of the snow and where the soil is not frozen, water may then also infiltrate into the soil, and thus the peak flows and runoff volumes are lower. A general approach for modeling the runoff process has been developed. The catchment area will be discretized into subcatchments consisting of two main parts: snow-covered areas, and areas without snow. Flow running from the subcatchments is collected by gutters and finally the water enters the sewer network through the inlets represented by the computational nodes in the network discretization. The governing equations include the mass conservation equation, the momentum conservation equation for pervious and impervious areas without snow and snow-covered areas topped by ice cover, and momentum conservation equation for subsnow flow. (See also W91-07920) (Fish-PTT)
W91-07933

SCHEME OF CALCULATING SINGLE-LAYER OVERTHRUST OF ICE ONTO A SHORE SLOPE.
I. E. Kozitskii.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 5, p 297-299, 1990. 1 tab, 5 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 5, p 20-21, May, 1990.

Descriptors: *Energy, *Ice, *Ice cover, *Lake ice, *Mathematical analysis, *Shores, Floating ice, Ice overthrust, Lake shores, Lakes, Mathematical equations, Reservoirs.

A scheme for the calculation of single-layer overthrust of ice onto a shore slope is presented. The problem of the extent of overthrust of ice onto a shore slope is approached by calculating the balance of energy rather than the balance of forces. The energy of each of the 1-m bands into which the ice floe is mentally divided is expressed in terms of the length, thickness and speed of the band, the density of ice and the acceleration of gravity. Thrusting at a right angle to a gently sloping shore, the ice floe breaks into pieces, which sequentially are pressed upslope. The scheme considers that the energy of the moving ice floe is spent on overcoming the gravitational and frictional forces. Using tabulated values of the friction coefficient and taking into account that the maximum speed of ice floes on lakes and reservoirs is 0.5 m/sec, the maximum values for overthrust of ice floes onto the shore can be obtained. For example, an ice floe with a thickness of 1 m and length of 100 m will be thrust a maximum of 8.6 m onto a 1:5 slope. Application of the scheme for calculating ice overthrust depends upon the form of deposition of ice on the shore. When a critical force is reached, the single layer system does not apply and hummocking occurs. (MacKeen-PTT)
W91-08029

BROWN SNOW: A LONG-RANGE TRANSPORT EVENT IN THE CANADIAN ARCTIC.
Department of Fisheries and Oceans, Winnipeg (Manitoba). Freshwater Inst.
For primary bibliographic entry see Field 5B.
W91-08102

2D. Evaporation and Transpiration

METEOROLOGIC AND HYDROLOGIC DATA COLLECTED FOR COMPUTING EVAPORATION FROM DEVILS LAKE, NORTH DAKOTA, 1986-88.
Geological Survey, Bismarck, ND. Water Resources Div.
B. A. Sether, and G. J. Wiche.
Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. North Dakota State Water Commission Water-Resources Investigations Report 10, 1989. 172p, 33 tab, 1 plate.

Descriptors: *Devils Lake, *Evaporation, *Hydrologic data collections, *Meteorological data collection, *North Dakota, Air temperature, Conductivity, Data collections, Dissolved oxygen, Humidity, Hydrogen ion concentration, Radiation.

Meteorologic and hydrologic data were collected in the Devils Lake basin, northeast North Dakota, to evaluate evaporation from Devils Lake. Meteorologic data collected include shortwave and longwave radiation, air temperature, relative humidity, wind speed, wind direction, precipitation, and dry and wet bulb temperature. Hydrologic data collected include water temperature, specific conductance, pH, and dissolved oxygen. The data are presented for calendar years 1986 through 1988. (Author's abstract)
W91-07188

USING A PROGRAMMABLE CALCULATOR FOR DETERMINING POTENTIAL EVAPORATION RATES.
Fort Lauderdale Research and Education Center, FL.
G. E. Fitzpatrick, and S. D. Verkade.
Journal of Environmental Horticulture JEHOD5, Vol. 7, No. 3, p 118-121, February 1991. 2 tab, 8 ref.

Descriptors: *Computer programs, *Crop production, *Evapotranspiration potential, *Irrigation scheduling, *Mathematical models, *Plant-water relationships, *Thornthwaite procedure, Analytical methods, Cost analysis, Irrigation, Nursery crops, Performance evaluation, Temperature.

Supplying irrigation in correct amounts and at proper intervals can be pivotal in the successful production of a nursery crop. A program is presented allowing the computation of uncorrected potential evapotranspiration (ET-p) rates a using low-cost (<$50) hand-held programmable calculator. This program requires the user to supply average local or on-site monthly temperatures. The first part of the program computes the annual heat index and the exponent necessary for ET-p determination. The second part of the program computes monthly ET-p rates by the Thornthwaite procedure as each average monthly temperature is keyed in. Comparisons of computed ET-p rates with measured actual evapotranspiration rates of various container-grown nursery crops show good correlation. (Author's abstract)
W91-07579

CONTRIBUTION TO RESEARCH OF EVAPOTRANSPIRATION USING REMOTELY SENSED CROP TEMPERATURE.
Ljubljana Univ. (Yugoslavia). Div. for Agricultural Water Management and Engineering.
B. Maticic, and M. Feges.
IN: Regionalization in Hydrology. IAHS Publication No. 191. International Association of Hydrological Sciences, Washington, DC. 1990. p 21-24, 2 fig, 5 ref.

Descriptors: *Data acquisition, *Evapotranspiration, *Infrared imagery, *Remote sensing, *Yugoslavia, Eddy diffusion, Energy balance, Grasslands, Heat transfer, Lysimeters, Penman equation, Wind.

The estimation of evapotranspiration by the modified Penman-Monteith method is based on the energy balance equation involving net radiation flux, latent heat flux, sensible heat flux, and soil heat flux. The crop canopy (grass) temperature in a large weighing lysimeter was measured at a research facility in Yugoslavia using a remote infrared thermometer. The energy balance for the atmosphere-crop plane was calculated as well as the turbulent diffusion resistance for heat transfer, these being the basic parameters for the estimation of evapotranspiration. Differences in energy balance were found to be due to too short a time averaging interval, which will be extended in the future. In the future, heat flux will be measured with a soil heat flux plate in order to obtain more realistic data. The relation between calculated values of turbulence diffusion resistance for different wind speeds will be used for the determination of evapotranspiration by the Penman-Monteith method. (See also W91-07920) (Fish-PTT)
W91-07923

2E. Streamflow and Runoff

NUTRIENT LOADING STATUS OF THE CONESTOGA RIVER BASIN, 1985-1989.
Susquehanna River Basin Commission, Harrisburg, PA. Resource Quality Management and Protection Div.
For primary bibliographic entry see Field 5B.
W91-07209

EFFECT OF SUBSTRATE COMPOSITION ON DETRITUS ACCUMULATION AND MACROINVERTEBRATE DISTRIBUTION IN A SOUTHERN NEVADA DESERT STREAM.
Nevada Univ., Las Vegas. Dept. of Biological Sciences.
For primary bibliographic entry see Field 2H.
W91-07399

FISHES OF THE RIO DE LA CONCEPCION BASIN, SONORA, MEXICO, AND THE STATUS OF THE SONORA CHUB, GILA DITAENIA, A SPECIES IN DANGER OF EXTINCTION (LOS PECES DE LA CUENCA DEL RIO DE LA CONCEPCION, SONORA, MEXICO, Y EL ESTATUS DEL CHARALITO SONORESE, GILA DITAENIA, UNA ESPECIE EN AMENAZA DE EXTINCION).
Arizona Game and Fish Dept., Phoenix.
For primary bibliographic entry see Field 2H.
W91-07401

RIVERINE FORESTS.
East Carolina Univ., Greenville, NC. Dept. of Biology.
M. M. Brinson.
IN: Forested Wetlands. Ecosystems of the World, 15. Elsevier Science Publishing Co., New York. 1990. p 87-141. 18 fig, 11 tab, 153 ref.

Descriptors: *Flood plains, *Forests, *Reviews, *Swamps, *Wetland forests, Arid climates, Biogeography, Biomass, Buffering, Climates, Flooding, Geomorphic characteristics, Hydrologic aspects, Hydroperiod, Ice drift, Nutrients, Salinity,

Sediment transport, Sediments, Species composition, Topography, Tundra, Water quality.

Riverine forests are those that owe their dynamics, structure, and composition to river processes of inundation, transport of sediments, or the abrasive and erosive forces of water and ice movement. These forests owe their uniqueness to the special hydrologic conditions and geomorphic, dynamic characteristic of floodplains. They vary in structure from communities of massive trees which tolerate deep flooding in the humid tropics, to shrub thickets in the Arctic tundra which sprout after periodic scour by ice and gravel. Within a geomorphic context, the climate, hydroperiod, salinity, and biogeographic location are the four principal factors that influence species composition. Historical patterns of river channel movement, induced by infrequent catastrophic floods, are responsible for the gross topographic features found in riverine forests. In general, riverine forest have greater basal area, biomass, and biomass production rates than uplands of the same location, a pattern which is most striking in arid climates. As a result of their position in the landscape, riverine forests play a critical role, disproportionately large for their size, in buffering potential impacts on water quality of rivers from disturbances in upland ecosystems. Since these forests are so dependent on imported water, nutrients, and sediments, they are therefore also vulnerable to alteration when deprived of these materials. In this review, emphasis was placed on the wide variety of riverine forests that occur in the U.S.A and Canada. (See also W91-07424) (Medina-PTT)
W91-07428

WOODED SWAMPS IN NEW GUINEA.
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Land Research.
For primary bibliographic entry see Field 2H.
W91-07437

DISSOLVED INORGANIC ALUMINUM IN ACIDIC STREAM AND SOIL WATERS IN WALES.
Institute of Hydrology, Wallingford (England).
For primary bibliographic entry see Field 5B.
W91-07483

CATCHMENT CHARACTERISTICS AND BASIN HYDROLOGY: THEIR EFFECTS ON STREAMWATER ACIDITY.
NRA Welsh Region, Cardiff.
For primary bibliographic entry see Field 5B.
W91-07485

FLOW IN A RIVER AFTER RUPTURE OF A DAM: CALCULATION BY THE FINITE DIFFERENCES METHOD WITH ASSOCIATED FLOW CHARACTERISTICS (ECOULEMENT EN RIVIERE APRES UNE RUPTURE DE BARRAGE: CALCUL PAR LA METHODS DES DIFFERENCES FINIES ASSOCIEES AVEC DES CARACTERISTIQUES).
Institute of Mathematics, Hanoi (Vietnam).
H. Q. On, and T. G. Lich.
Houille Blanche HOBLAB, Vol. 1990, No. 6, p 433-440, 1990, 8 fig, 1 tab, 10 ref. English summary.

Descriptors: *Dam failure, *Finite difference methods, *Flow characteristics, *Flow equations, *Hydrodynamics, *Model studies, *Open-channel flow, *River flow, Algorithms, Hydraulic geometry, Mass balance, St Venant equation, Wave propagation.

Equations of flow based on the mass balance of open-channel flow were combined with the Saint Venant equations to form hyperbolic quasilinear equations. This algorithm was applied to a hypothetical natural river of 400 km length with a dam at 200 km. The initial depth of the water above the dam was 104 m and, below the dam, 9 m. The initial flow was 11,000 cu m/sec. The channel widths, water levels, and the areas of transverse sections were all known. This model showed that when a dam ruptures, a discontinuity (wave) begins to propagate downstream. Calculations indicated that the discontinuity would move 43 km downstream in 53 min. (King-PTT)
W91-07531

EMERGENCE OF STONEFLIES (PLECOPTERA) FROM THE ROSEAU RIVER, MANITOBA.
Department of Fisheries and Oceans, Winnipeg (Manitoba). Freshwater Inst.
J. F. Flannagan, and D. G. Cobb.
American Midland Naturalist AMNAAF, Vol. 125, No. 1, p 47-54, January 1991. 3 fig, 3 tab, 31 ref.

Descriptors: *Aquatic insects, *Baseline studies, *Canada, *Drought effects, *Interbasin transfers, *Introduced species, *Irrigation projects, *Life history studies, *Manitoba, *Roseau River, *Stoneflies, *Stream biota, Aquatic habitats, Population dynamics, Seasonal variation, Species diversity, Substrates, Water temperature.

Emergence of aquatic insects from an area of rapids and an associated pool in the Roseau River, Manitoba, was studied in 1976 and 1977 as part of a project to provide background information on the aquatic insect fauna of the Churchill/Nelson drainage system. The project was initiated because a proposed irrigation scheme in the north-central United States would divert water from the Mississippi/Missouri drainage system to the Churchill/Nelson system and there was a possibility of transfer of exotic aquatic insect species into Manitoba waters. Four 1 sq. m box-emergence traps were positioned over four substrates (boulder, cobble, gravel and sand) in a section of riffle and an associated pool in the Roseau River. Sampling was conducted during the open water seasons of 1976 and 1977 and traps were emptied every 2nd day. There were 1808 stoneflies representing 7 species, and 412 stoneflies representing 6 species caught in 1976 and 1977, respectively. The reduction in density and numbers of species in 1977 is postulated to be the result of a drought late in 1976. Stoneflies emerged 6-10 days earlier in 1977 compared to 1976 as a result of higher spring water temperatures in 1977. Stonefly emergence date could be predicted from the sum of degree-days in the spring of their emergence year. Most emergence occurred at night or in the morning but a few individuals emerged during the brightest part of the day. Numerical abundance for most species was highest over larger substrates (boulder and cobble) in 1976, whereas in 1977 an unexpectedly large number emerged over smaller substrates (gravel and sand). (Author's abstract)
W91-07550

STRONTIUM IN RIVERS OF THE BALTIC BASIN.
Stockholm Univ. (Sweden). Dept. of Geology.
For primary bibliographic entry see Field 2K.
W91-07553

INFLUENCE OF A FLOOD EVENT ON PHYTOPLANKTON SUCCESSION.
Zurich Univ., Kilchberg (Swizerland). Hydrobiological-Limnological Station.
For primary bibliographic entry see Field 2H.
W91-07554

UNIONIDAE OF THE CHAGRIN RIVER: THE REMNANT OF A MOLLUSCAN FAUNA.
Ohio Dept. of Natural Resources, Columbus. Div. of Natural Areas and Preserves.
M. A. Hoggarth.
Ohio Journal of Science OJSCA9, Vol. 90, No. 5, p , December 1990.

Descriptors: *Chagrin River, *Ecological distribution, *Freshwater mussels, *Mollusks, *Ohio, *Stream biota, Aquatic animals, Biogeography, Distribution patterns, Species composition, Species diversity, Water quality control, Waterfalls.

The study of the distribution of the Unionidae of Ohio reveals information on the biogeography of this family that may be useful in the study of other groups of animals. Thirty sites in the Chagrin River and its major tributaries, the East and Aurora branches, were sampled for freshwater mussels during this study. A total of 268 specimens representing nine species of the family Unionidae were found. Living and/or freshly dead specimens of eight species were identified. Additionally, a single subfossil fragment of Alasmidonta marginata was taken, indicating that this species once occurred in the river. Three reaches of the Chagrin River system supported Unionidae: the Aurora branch contained five species, the main stem of the Chagrin River below the town of Chagrin Falls contained five species, and the Chagrin River above Chagrin Falls contained seven species. The river above the falls contained the most significant proportion of the fauna in the system, with over 80% of all specimens collected from this reach, and suggests that the falls has not always acted as a barrier to distribution. Whatever the source of the Unionidae of the upper Chagrin River, it a apparent that this unexpected fauna has been isolated since the river established its current drainage pattern. Any threat that reduces habitat diversity, water quality, or substrate stability in this reach has the potential to significantly reduce species diversity in the entire system. (Author's abstract)
W91-07572

FISHES OF CRUTCHO CREEK AND THE NORTH CANADIAN RIVER IN CENTRAL OKLAHOMA: EFFECTS OF URBANIZATION.
Oklahoma Univ., Kingston. Biological Station.
For primary bibliographic entry see Field 4C.
W91-07576

SPAWNING AND MOVEMENTS OF RAZORBACK SUCKER, XYRAUCHEN TEXANUS, IN THE GREEN RIVER BASIN OF COLORADO AND UTAH.
Fish and Wildlife Service, Vernal, UT.
For primary bibliographic entry see Field 8I.
W91-07577

AUTUMN SPAWNING AND OTHER REPRODUCTIVE NOTES ON LOACH MINNOW, A THREATENED CYPRINID FISH OF THE AMERICAN SOUTHWEST.
Arizona State Univ., Tempe. Dept. of Zoology.
For primary bibliographic entry see Field 8I.
W91-07578

RUNOFF AND PEAK DISCHARGES USING GREEN-AMPT INFILTRATION MODEL.
Soil Conservation Service, Bozeman, MT.
For primary bibliographic entry see Field 2A.
W91-07593

UNIFIED THEORY ON POWER LAWS FOR FLOW RESISTANCE.
Geological Survey, Menlo Park, CA. Water Resources Div.
For primary bibliographic entry see Field 8B.
W91-07594

STABILITY OF GRADUALLY VARYING FLOW IN WIDE OPEN CHANNELS.
Technische Hogeschool Delft (Netherlands). Dept. of Civil Engineering.
C. Kranenburg.
Journal of Hydraulic Research JHYRAF, Vol. 28, No. 5, p 621-628, 1990. 3 fig, 8 ref.

Descriptors: *Hydraulic engineering, *Open-channel flow, *Wave height, *Wave propagation, *Waves, Flow equations, Flow velocity, Froude number, Surface flow, Wave action.

High-velocity free surface flows may exhibit instabilities which develop from small initial disturbances and grow until a series of breaking waves or roll waves are formed. Stability criteria and growth rates of long-wave disturbances in gradually varying open-channel flow were derived from an amplitude evolution equation for weakly nonlin-

ear shallow-water waves. In the case of uniform flow, it was shown that a disturbance propagating against the current is always stable, and that a disturbance travelling with the current becomes unstable if the Froude number is greater than 2. The streamwise nonuniformity of the flow was found to influence the stability substantially, in accord with previously-published results. For example, supercritical flows on a horizontal bed are always unstable, and in certain cases even subcritical flows are unstable for disturbances travelling with the current as well as against it. The behavior of the instabilities was examined by extending the amplitude evolution equation with higher-order contributions. It can be shown that steady, periodic solutions do not exist in the case of nonbreaking waves. However, these solutions do exist for breaking waves. Wave growth caused by instability is then balanced by the dissipative effect. Roll waves tend to merge to form longer and higher roll waves. (Fish-PTT)
W91-07602

KRIGING TECHNIQUE FOR RIVER FLOOD REPRESENTATION (LE KRIGEAGE DUAL, UNE TECHNIQUE POUR LA CARTOGRAPHIE AUTOMATISEE DES ZONES D'INONDATION).
Ecole Polytechnique, Montreal (Quebec). Groupe de Recherche CASTORPLUS.
For primary bibliographic entry see Field 7B.
W91-07603

APPLICATIONS OF HYDROLOGIC INFORMATION AUTOMATICALLY EXTRACTED FROM DIGITAL ELEVATION MODELS.
EROS Data Center, Sioux Falls, SD.
For primary bibliographic entry see Field 7C.
W91-07617

CONTINENTAL HYDROLOGICAL ASSESSMENT OF A NEW GRID-BASED DIGITAL ELEVATION MODEL OF AUSTRALIA.
Australian National Univ., Canberra. Centre for Resource and Environmental Studies.
For primary bibliographic entry see Field 7C.
W91-07618

PREDICTION OF HILLSLOPE FLOW PATHS FOR DISTRIBUTED HYDROLOGICAL MODELLING USING DIGITAL TERRAIN MODELS.
Lancaster Univ. (England). Centre for Research on Environmental Systems.
For primary bibliographic entry see Field 7C.
W91-07619

EXTRACTION OF CHANNEL NETWORKS FROM DIGITAL ELEVATION DATA.
Massachusetts Inst. of Tech., Cambridge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 7C.
W91-07620

TERRAIN ANALYSIS FOR URBAN STORMWATER MODELLING.
Texas Univ. at Austin. Dept. of Civil Engineering.
For primary bibliographic entry see Field 7C.
W91-07622

PEAKFLOW ESTIMATION USING AN ANTECEDENT PRECIPITATION INDEX (API) MODEL IN TROPICAL ENVIRONMENTS.
Oregon State Univ., Corvallis. Agricultural Experiment Station.
For primary bibliographic entry see Field 7C.
W91-07726

FLOOD AND LANDSLIDE HAZARD MAPPING, SOLOMON ISLANDS.
Department of Scientific and Industrial Research, Palmerston North (New Zealand). Div. of Land and Soil Sciences.
N. A. Trustrum, I. E. Whitehouse, P. M. Blaschke, and P. R. Stephens.
IN: Research Needs and Applications to Reduce Erosion and Sedimentation in Tropical Steeplands. IAHS Publication No. 192. International Association of Hydrological Sciences, Washington, DC. 1990. p 138-146. 1 fig, 1 tab, 7 ref.

Descriptors: *Cyclones, *Flood forecasting, *Flooding, *Hazard assessment, *Landslides, *Solomon Islands, Aerial photography, Cyclone Namu, Flood frequency, Flood hazard, Guadalcanal, Malaita, Mapping, Simulation analysis, Stream channels.

Cyclone Namu in 1986 highlighted the enormity of the risk to life and property on Guadalcanal from natural hazards. Buildings, roads, bridges, crops and forests were destroyed and at least 100 people were killed. An aerial photographic reconnaissance survey of the two most severely damaged islands, Guadalcanal and Malaita, was undertaken three months after the storm. To assist the Solomon Islands Government in reducing the impact of future disasters, flood and landslide hazard mapping was later completed for eight major watersheds in northern Guadalcanal. Over 75% of the 400 sq km Guadalcanal plain flooded in Cyclone Namu and can be expected to flood in similar low probability events in the future. Areas of frequent flooding are confined to the river channels and adjacent low terraces. Most of the plain has a moderate flood hazard, with the likelihood of flooding occurring in any one year assessed as 1 to 5%. Impeded drainage makes surface water flooding a problem over much of the plain. Landsliding is frequent on steep slopes in the mountains and is most widespread in Mbalisuna, Ngalimbiu and Mberande watersheds. Siting of developments, both existing and proposed, should consider the consequences of flooding and landsliding. Ideally, new development should occur in areas considered safe or with a low probability of flooding or landsliding. Where applicable, protection from flooding may be required. Evacuation strategies and relief planning also may be improved to cope with future flooding. (See also W91-07713) (Author's abstract)
W91-07727

SURFICIAL PROCESSES IN THE RAINFOREST OF WESTERN AMAZONIA.
Bern Univ. (Switzerland). Geographisches Inst.
For primary bibliographic entry see Field 2J.
W91-07742

LOW FLOWS DURING THE 1988 DROUGHT IN TENNESSEE.
Geological Survey, Nashville, TN. Water Resources Div.
J. F. Lowery, and J. F. Connell.
Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4149, 1990. 1p, 2 fig, 1 tab, 3 ref.

Descriptors: *Drought, *Hydrologic maps, *Low flow, *Maps, *Tennessee, Flow profiles, Networks, Precipitation, Rainfall, Rainfall-runoff relationships, Specific conductivity, Streamflow, Temperature, Water deficit.

A severe drought occurred across large areas of Tennessee during the summer of 1988. Rainfall, which was below normal in the previous 2 yrs, totaled only 39.4 inches in 1988 and was 8.8 inches below the 1951-80 normal of 48.2 inches. Streamflows across the State declined with the reduction in rainfall, and water supplies became critically low in several communities in Middle Tennessee that rely on surface water sources for their supply. To document the intensity (or severity) of the drought, the US Geological Survey, in cooperation with the Tennessee Department of health and Environment, measured low flows throughout the State during the summer of 1988. An intensive program, which initially included the measurement of streamflow at 198 sites, was begun in early 1988. Streamflow measurements were made at sites where flow was present, and dry conditions were recorded at sites where there was no flow. Measurements at selected sites from the network and at 60 additional sites were made during August and September 1988. The specific conductance and temperature of the water were recorded at most of the sites where streamflow measurement was made. For most of the sites visited during July 1988, the 3-day 20-yr (3Q20) recurrence-interval minimum flow had been defined during previous investigations. The lowest measured flows in summer 1988 and the 3Q20 low flow data are presented along with data collected during the low flow study, including the discharges and specific conductance and temperature measurements. (Author's abstract)
W91-07812

INFLUENCE OF MICROFORM BED ROUGHNESS ELEMENTS ON FLOW AND SEDIMENT TRANSPORT IN GRAVEL BED RIVERS.
London Univ. (England).
For primary bibliographic entry see Field 2J.
W91-07851

MODELLING PHOTOSYNTHETIC OXYGEN PRODUCTION IN RIVERS.
Florence Univ. (Italy). Dept. of Systems and Computer Science.
For primary bibliographic entry see Field 2H.
W91-07858

EFFECTS OF LIVESTOCK GRAZING ON RIPARIAN AND STREAM ECOSYSTEMS.
For primary bibliographic entry see Field 4C.
W91-07867

REGIONALIZATION IN HYDROLOGY.
For primary bibliographic entry see Field 2A.
W91-07920

REMOTE-SENSING TECHNIQUES FOR DETERMINING THE REGIONALLY VARIABLE CHARACTERISTICS OF DRAINAGE BASINS.
Institutul de Meteorologie si Hidrologie, Bucharest (Romania).
H. Grumazescu, G. Stancalie, and C. Ungureanu.
IN: Regionalization in Hydrology. IAHS Publication No. 191. International Association of Hydrological Sciences, Washington, DC. 1990. p 3-10, 4 fig, 3 ref.

Descriptors: *Catchment areas, *Hydrologic data collections, *Hydrologic models, *Regional analysis, *Remote sensing, *Terrain analysis, Data interpretation, Geographic information systems, Landsat images, Romania, Snowmelt, Surface runoff.

Image data obtained by means of aerial photographs or from MSS Landsat records can be valuable information sources for the analysis of the factors characterizing spatial variability that influence and condition the water runoff in a drainage basin. These methods were used for the determination of the characteristics of the basins on a local and regional scale. The established land unit was the 'facet' defined as a relief element, homogeneous from the standpoint of factors acting upon the water runoff. The transition from the local to the regional scale was achieved by successive integration of 'facets' in elementary drainage basins, and these in basins of higher order. The storage and handling of data on the characteristic features of the 'facets' in a drainage basin were based on a Geographic Information System principle. The data defining the physical characteristics of 'facets' were organized in a file structured on items, each item explicitly containing the space localization code, the order of the basin and the distance from the control section, the surface, the elevation range, the slope, its orientation, the roughness, the land cover, and the soil granulometry. Data on a single component of the 'morphological' system for a 'facet' or an elementary catchment area, or data on all the components within their space interrelation at the level of the 'facets' or of the catchment area, can be made available. These techniques are currently used in Romania to provide relevant information for developing and updating snowmelt-runoff models. (See also W91-07920) (Fish-PTT)
W91-07921

ENVIRONMENTAL TRACER APPROACH AS A TOOL FOR HYDROLOGICAL EVALUATION AND REGIONALIZATION OF CATCHMENT SYSTEMS.
Technische Univ. Braunschweig (Germany, F.R.). Inst. fuer Geographie.
A. Herrmann, B. Finke, M. Schoniger, P. Maloszewski, and W. Stichler.
IN: Regionalization in Hydrology. IAHS Publication No. 191. International Association of Hydrological Sciences, Washington, DC. 1990. p 45-58, 3 fig, 4 tab, 22 ref.

Descriptors: *Environmental tracers, *Europe, *Hydrologic budget, *Hydrologic models, *Isotopic tracers, *Regional analysis, *Small watersheds, *Surface-groundwater relations, Flood hydrographs, Forest hydrology, Groundwater recharge, Hydrograph analysis, Hydrologic cycle, Mathematical models, Model studies, Recharge basins, Watersheds.

The contribution of environmental isotope tracer techniques (3-H, 2-H, 18-O) to new insights into turnover mechanisms of water in small hydrological catchment systems were examined with respect to their regionalization. Areal hydrological and hydraulic parameters with the most important direct and indirect runoff proportions as well as mean transit times and storage volumes of mobile water for distinct subsurface reservoirs, respectively, were determined from isotopical hydrograph separation and mathematical flow model application to isotopical system functions using the Lange Bramke basin (Harz Mountains in Central Europe) of fractured Paleozoic rock and 0.76 sq m as an example. Special attention is drawn to differences between these modern and classical basin water balances. Accordingly, the classical methods considerably underestimate flood hydrograph generation by dominant groundwater supply, and groundwater recharge rates by up to two to three times. Finally, the concept for a hydrodynamic (numerical) catchment model was propagated for regionalization of main hydrological processes and parameters mentioned, by introducing the forest hydrological BROOK model as a very promising starting point. (See also W91-07920) (Author's abstract)
W91-07926

LARGER-SCALE HYDROLOGICAL MODELLING FOR REGIONAL TRANSFERRING OF HYDROLOGICAL INFORMATION.
Institut fuer Wasserwirtschaft, Berlin (German D.R.).
A. Becker, and B. Pfuetzner.
IN: Regionalization in Hydrology. IAHS Publication No. 191. International Association of Hydrological Sciences, Washington, DC. 1990. p 61-68, 4 fig, 11 ref.

Descriptors: *Hydrologic models, *Large watersheds, *Model studies, *Regional analysis, *Surface-groundwater relations, Closed basins, Germany, Groundwater movement, Hydrologic budget, Infiltration, Model testing, Soil water.

Conceptual hydrological models may be used efficiently for larger-scale hydrological modeling. In modeling groundwater flow it is important to identify hierarchically-nested local, intermediate, and regional groundwater flow systems and to define an adequate model structure. The application of a two-level modeling concept is recommended: a first-level model which concerns all vertical processes, and a second-level model which concerns the more or less lateral flow processes in different levels and subsystems and which is principally river-basin and groundwater systems oriented. Proceeding from the specific objective of the given modeling task, first the time step for computations must be fixed and then, as the first major modeling step, the structure of the model under development must be defined. As wet areas often occur as closed subareas in a river basin, their moisture regime (water balance) can be handled effectively 'en bloc.' The hydrological processes occurring at the land surface, especially direct runoff formation and evapotranspiration, are characterized by significant areal variability, due to the heterogeneity of land surfaces and soil conditions. Therefore, it is necessary to apply a distributed model, in particular, in the first-level modeling. Most of these working principles were tested practically in river basins in the northern lowlands of Germany. It was found that the approach used for estimation of the parameters of the soil capillary water model permits use of generally available data on the distribution of soil types. An advanced model was developed and tested which better takes into account the interrelationships between infiltration and exfiltration areas. Drainage flow can make up an important portion of direct runoff. This scheme offers some advantages and simplifications in contrast to grid-based distributed models. (See also W91-07920) (Fish-PTT)
W91-07927

DISTRIBUTED MODEL DESCRIBING THE INTERACTION BETWEEN FLOOD HYDROGRAPHS AND BASIN PARAMETERS.
Graz Univ. (Austria). Inst. for Hydromechanics, Hydraulics and Hydrology.
H. Bergmann, G. Richtig, and B. Sackl.
IN: Regionalization in Hydrology. IAHS Publication No. 191. International Association of Hydrological Sciences, Washington, DC. 1990. p 91-102, 6 fig, 4 ref.

Descriptors: *Flood basins, *Flood hydrographs, *Hydrograph analysis, *Hydrologic models, *Model studies, *Rainfall-runoff relationships, *Regional analysis, Catchment areas, Concentration time, Flood recurrence interval, Flood routing, Retarding basins, Runoff, Synthetic hydrology.

The solution of water management problems often requires synthetic flood hydrographs. A detailed model has been developed which offers the possibility to determine the connection between a given flood hydrograph and basin parameters. First the determination of a certain return period (years) flood hydrograph using a bivariate regionalization formula is introduced. Next a drainage basin is structured into square grids and the relative runoff coefficient and the concentration time value parameters are calculated for each square. The model is based mainly on the application of a linear routing model in order to calculate the relation between a normalized mass-transport diagram and the standardized flood hydrograph. In planning flood-retention basins, a frequent question concerns the effects of such structures on the hydrographs of flood events with a certain return period at a certain point downstream. To obtain the changed flood hydrograph for the whole drainage basin, it is necessary to superimpose two partial hydrographs--one for the area which will not be affected by retention measures, and one for the area that will be affected. (See also W91-07920) (Author's abstract)
W91-07930

STUDY OF CEVENNES FLOODS: FLOOD GENESIS IN A SMALL FORESTED BASIN SOUTH OF MONT LOZERE, FRANCE (ETUDE DES CRUES CEVENOLES: CONDITIONS D'APPARITION DANS UN PETIT BASSIN FORESTIER SUR LE VERSANT SUD DU MONT LOZERE, FRANCE).
Laboratoire de Geographie Physique, Meudon-Bellevue (France).
C. Cosandey, and J. F. Didon-Lescot.
IN: Regionalization in Hydrology. IAHS Publication No. 191. International Association of Hydrological Sciences, Washington, DC. 1990. p 103-115, 9 fig, 1 tab, 13 ref. English summary.

Descriptors: *Flood discharge, *Floods, *France, *Mountain streams, *Rainfall-runoff relationships, *Small watersheds, Groundwater storage, Rainfall, River basins, River flow, Soil water potential, Water table rise.

Flood genesis was studied in a small forested drainage basin situated on the south face of Mont Lozere (France). The existence of a threshold was determined, beyond which the water in the river rises suddenly and quickly, passing in a few hours from 300 L/s/sq km to 1 or perhaps 2 cu m/s/sq km, with continuing rainfall. This threshold corresponds to about 270 mm for water storage of the basin (the sum of groundwater and soil storage). The amount of rain needed to reach this threshold varies from 44 to 216 mm, depending on the amount of this storage at the beginning of the rainfall event. This observation allows an interpretation of the flood runoff as the result of an overflowing of temporary water tables, which saturate large parts of the basin. Under such conditions, the role of vegetal cover appears to be of secondary importance. (See also W91-07920) (Author's abstract)
W91-07931

ESTIMATING FLOW CHARACTERISTICS AT UNGAUGED SITES.
Geological Survey, Reston, VA.
H. C. Riggs.
IN: Regionalization in Hydrology. IAHS Publication No. 191. International Association of Hydrological Sciences, Washington, DC. 1990. p 159-169, 3 fig, 2 tab, 14 ref.

Descriptors: *Flow characteristics, *Flow measurement, *Gaging, *Hydrologic models, *Regional analysis, *Stage-discharge relations, *Streamflow data, Catchment areas, Channel morphology, Flood peak, Flow discharge, Gaging stations, Low flow, Stream gages.

Given a network of gaging stations and data on the climatic and physical characteristics of drainage basins in the region, one can relate flow characteristics to basin characteristics and use the relation to estimate flow characteristics at ungaged sites (regional analysis). The desired flow characteristics are computed from the streamflow records and are related by multiple regression to climatic and basin characteristics defined from weather records and maps. A log linear model is commonly used, and the reliability of the regression equation is considered to be represented by the standard error. Where such relations are not well-defined, methods that require collection of some information at the ungaged site may be applicable. Low flow characteristics at an ungaged site may be estimated from discharge measurements of base flow made several times a year for two or more years and related to concurrent discharges of a nearby gaged stream for which the low flow characteristics have been computed. Relations of channel width to various flood peak characteristics may be used to make estimates at ungaged sites. Channel widths at bankfull stage are measured at the gaged sites and those widths are related to flood peak characteristics at some specific recurrence interval. In regions where mean flows are not closely related to drainage area and where basin precipitation cannot be reliably estimated, mean flow of an ungaged stream may be estimated from one discharge measurement near the middle of each of 12 consecutive months, and the record of a nearby gaged stream. On large streams interpolation between gaged points may be preferable. (See also W91-07920) (Fish-PTT)
W91-07936

CANONICAL CORRELATION APPROACH TO REGIONAL FLOOD ESTIMATION.
McGill Univ., Montreal (Quebec). Dept. of Civil Engineering.
G. S. Cavadias.
IN: Regionalization in Hydrology. IAHS Publication No. 191. International Association of Hydrological Sciences, Washington, DC. 1990. p 171-178, 5 fig, 1 tab, 20 ref.

Descriptors: *Flood basins, *Flood data, *Flood forecasting, *Maximum probable floods, *Regional analysis, *Regional floods, Annual floods, Canada, Correlation analysis, Flood frequency analysis, Homogeneity, Newfoundland.

A method of estimating the maximum annual floods of a basin has been developed which uses canonical correlation analysis between the basin characteristics and the characteristics of the distribution of the floods. The method helps to determine the degree of similarity between the groupings of basins in the spaces of the respective canonical variables of the basin and the flood characteris-

tics and provides a basis for the determination of the homogeneous regions in the space of basin characteristics which takes into account their relationships with the flood characteristics. The proposed method was used to estimate the quantiles of the distribution of the maximum annual flood in the province of Newfoundland, Canada. The results show that the a priori determination of 'homogeneous' regions and the use of predetermined regression equations for estimating the flood distributions of ungaged basins does not do justice to the difficulty of the flood estimation problem. The proposed approach of determining the 'neighborhoods' of an ungaged basin in the spaces of the canonical variables which are determined on the basis of flood characteristics is a step toward a more flexible estimation of the distribution of maximum floods and enables the design engineer to make greater use of this knowledge of the basin for assessing the similarity of the basin with the other basins in its neighborhood. (See also W91-07920) (Fish-PTT)
W91-07937

USE OF L-MOMENTS FOR REGIONALIZING FLOW RECORDS IN THE RIO URUGUAI BASIN: A CASE STUDY.
Instituto de Pesquisas Hidraulicas, Porto Alegre (Brazil).
R. T. Clarke, and L. E. Montenegro Terrazas.
IN: Regionalization in Hydrology. IAHS Publication No. 191. International Association of Hydrological Sciences, Washington, DC. 1990. p 179-185, 2 tab, 5 ref.

Descriptors: *Flow discharge, *Mathematical studies, *Probability distribution, *Regional analysis, Basins, Brazil, Regression analysis, Rio Vruguai Basin, Statistical analysis.

The hydrological application of probability-weighted moments (PWMs) has been extended to derive a set of quantities termed L-moments, which are weighted sums of the expected values of order statistics. Data from 29 sub-basins of the Rio Uruguai in southern Brazil were used to explore the use of L-moments to regionalize annual maximum mean daily discharge (y1). As first assumptions, a Gumbel distribution was taken to describe the probability distribution of y1, and basin area was taken as the principal basin characteristic in regression analyses. Multivariable (as distinct from multivariate) regressions were used to obtain estimates of L-moments of y1 for ungaged basins; and conventional moments of y1 for ungaged basins, and the two sets of moments were used to derive estimates of Gumbel parameters and hence estimates of y1 with given return periods, together with their approximate confidence limits. Use of L-moments gave estimates with narrower confidence limits than conventional moments, although the difference was not large. (See also W91-07920) (Author's abstract)
W91-07938

ESTIMATING HYDROLOGICAL PARAMETERS FROM BASIN CHARACTERISTICS FOR LARGE SEMIARID CATCHMENTS.
Hanover Univ. (Germany, F.R.). Inst. fuer Wasserwirtschaft, Hydrologie und Landwirtschaftlichen Wasserbau.
W. Reimers.
IN: Regionalization in Hydrology. IAHS Publication No. 191. International Association of Hydrological Sciences, Washington, DC. 1990. p 187-194, 1 fig, 2 tab, 14 ref.

Descriptors: *Annual runoff, *Model studies, *Parameter estimation, *Regional analysis, *River basins, *Semiarid climates, Annual floods, Brazil, Climatic data, Flow characteristics, Humid climates, Hydrologic data, Hydrologic models, Parametric hydrology, Regression analysis.

Climatic, physiographic, and land-use conditions influence the runoff from a basin directly and indirectly, and vary within a given basin and between basins. It is assumed that the processes affecting runoff can be described as linear dependencies between basin characteristics and hydrological variables. Mean annual runoff and mean daily annual flood were predicted from physiographic, climatic, and land-use basin characteristics for large catchments from the semiarid northeast of Brazil using multiple regression techniques. The regression models were found to be similar to models developed for other regions. Differences concerning the kind of basin characteristics incorporated and the values of regression coefficients can be partly explained by special climatic and physiographic conditions (semiarid climate, large mean size of investigated basins). In all cases basin size is a significant variable. The mean annual runoff is approximately proportional to basin size for a humid climate. The regression coefficient becomes 1.0 in this case. It is less than 1.0 for semiarid regions where high evapotranspiration and channel transmission losses affect runoff from large basins more than runoff from small ones. (See also W91-07920) (Fish-PTT)
W91-07939

REGIONAL ANALYSIS OF HYDROLOGICAL VARIABLES IN GREECE.
National Technical Univ., Athens (Greece). Dept. of Civil Engineering.
M. Mimikou.
IN: Regionalization in Hydrology. IAHS Publication No. 191. International Association of Hydrological Sciences, Washington, DC. 1990. p 195-201, 1 fig, 1 tab, 8 ref.

Descriptors: *Greece, *Hydrological models, *Model studies, *Regional analysis, *Stream discharge, *Streamflow forecasting, Annual floods, Flood discharge, Flow duration, Hydrologic properties, Sediment discharge, Ungaged basins, Unit hydrographs.

Data from drainage basins of five major rivers (the Aliakmon, Acheloos, Aracthos, Aoos, and Kalmas) in western and northwestern Greece were used to study regional analysis of various hydrological variables. The spatial variation of parameters of suspended sediment/water discharge rating curves, of maximum observed flood discharges, of lag times and unitgraph peaks for a certain storm duration, of parameters of flow duration curves, and of mean annual floods for these basins were satisfactorily explained in terms of physiographic and climatological characteristics by using stepwise multiple regression techniques. A logarithmic transformation was used for both dependent and independent variables, since this improved the linear association between them. The coefficient of determination was used as a measure of the association of the variables. A t-test was used to check that the regression coefficient of each independent variable was not significantly different from zero. The regional models thus developed were successfully used in predicting hydrological variables for ungaged basins within the regions studied. (See also W91-07920) (Author's abstract)
W91-07940

RAINFALL-RUNOFF MODEL FOR SMALL UNGAUGED WATERSHEDS IN POLAND.
Institute of Meteorology and Water Management, Warsaw (Poland).
For primary bibliographic entry see Field 2B.
W91-07941

REGIONALIZATION OF PARAMETERS USING BASIN GEOLOGY, LAND USE, AND SOIL TYPE FOR USE IN A STORM RAINFALL-RUNOFF RELATIONSHIP.
Tokyo Metropolitan Univ. (Japan). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2B.
W91-07942

MODEL FOR FORECASTING RUNOFF FROM MOUNTAINOUS RIVERS.
Srednеaziatskii Nauchno-Issledovatel'skii Gidrometeorologicheskii Inst., Tashkent (USSR).
I. D. Shentzis.
IN: Regionalization in Hydrology. IAHS Publication No. 191. International Association of Hydrological Sciences, Washington, DC. 1990. p 219-226, 3 fig, 6 ref.

Descriptors: *Mathematical models, *Model studies, *Mountain watersheds, *Regional analysis, *Runoff forecasting, *USSR, Meteorological data, Parametric hydrology, Probabilistic process, Snow cover, Snow storage, Weather forecasting.

In place of conventional statistical methods, a mathematical model was used for long-term prediction of runoff from mountainous rivers in central USSR. A submodel for snow cover dynamics computation appeared to be necessary due to the sparse snow-measuring network in the mountains. The zonality of all the natural processes in a mountainous region was accounted for by means of a transformation model with simplified parameters (computation of the transformation assumes parallel connection of elevation zones). If a reliable long-term weather forecast is not available, runoff is computed by a model using some probabilistic estimates of the meteorological situation during the growing season. Snow storages modeled to the date of a forecast and measured discharges during the previous period are used as initial conditions for runoff computations. Testing the method on rivers of Central Asia revealed that reliability of forecasts of seasonal runoff is 85-95% (5-6 months in advance), that for monthly runoff it is 75-95% (1-5 months in advance). A comparison with conventional statistical methods shows that the accuracy of forecasts is higher in April-May when model estimates of the remaining snow storage in a basin acquire particular importance. (See also W91-07920) (Fish-PTT)
W91-07943

WEIBULL DISTRIBUTION APPLIED TO REGIONAL LOW FLOW FREQUENCY ANALYSIS.
Environment Canada, Ottawa (Ontario). Water Resources Branch.
P. J. Pilon.
IN: Regionalization in Hydrology. IAHS Publication No. 191. International Association of Hydrological Sciences, Washington, DC. 1990. p 227-237, 1 fig, 4 tab, 17 ref.

Descriptors: *Low flow, *Model studies, *Regional analysis, *Statistical analysis, *Streamflow forecasting, *Ungaged basins, Canada, Catchment areas, Flood flow, Homogeneity, Ontario, Parametric hydrology.

The inability to estimate accurately low flows of specific duration and probability for ungaged basins has long plagued the practitioner. The index-flood method is one tool which may assist in this regard, through its adaptation to low flows. A procedure has been developed to extend the index-flood method to low flow analysis when the regional distribution is assumed to be the three-parameter Weibull (W3). The derivation of a homogeneity test was also developed. The approach was demonstrated by its application to an area in the southern portion of Ontario, Canada. The application of the index-low flow procedure illustrated some of its drawbacks. The success of regionalization depends on the ability to define homogeneous areas and on the accuracy and reliability of the regional dimensionless index curve. When applying the derived index-low flow method, a primary assumption is that the parent distribution is W3. This premise should always be investigated, as it is entirely plausible that low flows of a region are not drawn from this parent. When the parent is W3, the derived technique may provide useful results in many practical situations. (See also W91-07920) (Fish-PTT)
W91-07944

REGIONALIZED ESTIMATION OF RESERVOIR CAPACITY-YIELD CURVES IN HUNGARY.
Vizgazdalkodasi Tudomanyos Kutato Intezet, Budapest (Hungary).
M. Domokos, and A. Gilyen-Hofer.
IN: Regionalization in Hydrology. IAHS Publication No. 191. International Association of Hydrological Sciences, Washington, DC. 1990. p 239-251, 8 fig, 8 ref.

Descriptors: *Hungary, *Regional analysis, *Reservoir capacity, *Reservoir design, *Reservoir yield, *Streamflow, Computer programs, Effective capacity, Gaging stations, Model studies, Mountain streams, Stream discharge.

The capacity/yield curve having a selected reliability in a given stream section is a relationship between the utilizable capacity of the reservoir to be built in that section and the continuous and uniform yield that can be released with reliability from the reservoir. For determining these curves from observed discharge series, a computer program was developed by adopting the method of critical dry periods. Gaging stations whose discharge record up to 1982 was at least 30 years (and in some cases more than 80 years) long were selected on small streams in the hilly and mountainous regions of Hungary. Using the computer program, capacity/yield curves were generated from each possible continuous partial series of 5, 10, 15, 20, 30, and 50 years length, as well as from the full series. In this way, information was gained about how the reliability of the capacity/yield function depends on the record's length. By regional generalization, an empirical formula was also derived for estimating the capacity/yield curve in any ungaged stream section within the mountainous and hilly parts of Hungary. (See also W91-07920) (Author's abstract)
W91-07945

FISH POPULATIONS OF SIX ANCIENT ARMS OF THE GARONNE RIVER.
Ecole Nationale Superieure Agronomique de Toulouse (France). Lab. d'Ichthyologie Appliquee.
For primary bibliographic entry see Field 2H.
W91-07985

IMPACT OF EL NINO 1982 /EVENT ON THE PARANA RIVER, ITS DISCHARGE AND TRANSPORT.
Universidad Nacional de Cordoba (Argentina). Dept. de Quimica.
P. J. Depetris, and S. Kempe.
Paleo PPPYAB, Vol. 3, No. 3, p 239-244, December 1990, 3 fig, 1 tab, 21 ref.

Descriptors: *Climatology, *El Nino, *Excess rainfall, *Flood plains, *Floods, *Sediment transport, *South America, *Weather patterns, Carbon dioxide, Dissolved organic carbon, Floodwater, Parana River, Particulate matter, Southern oscillation, Water chemistry.

The 1982 El Nino/Southern Oscillation (ENSO) event was one of the strongest observed over a long period. It caused heavy precipitation over South America resulting in a once-in-a-century flood of the Parana floodplain. This flood reached 60% more annual discharge than the long-term average. The hydrochemistry of this flood was monitored at Santa Fe, situated on the flood plain, 600 km above the mouth of the Parana. During the flood, concentrations of total suspended and dissolved solids were lower than pre-ENSO averages, but loads were similar. The flood, therefore, had a simple dilution effect on the concentrations of major inorganic concentrations. Dissolved organic carbon load, however, increased by 2-3 times while particulate organic carbon (POC) transport fell by 40%, suggesting that the wooded flood plain is an effective filter for sediment and particulate debris. By comparison with the partial pressure of CO2 (pCO2), it is evident that DOC is more refractory in nature than POC. Thus the flood did not result in a flushing-out of particulate matter, rather the flood plain acted as a sink for particulates. Flushing-out was, however, observed for refractory dissolved organic carbon. Thus large floods may form an effective means of transfer for huge amounts of soil carbon to the ocean. (Doyle-PTT)
W91-08108

WATER QUALITY OF THE WEST BRANCH LACKAWAXEN RIVER AND LIMNOLOGY OF PROMPTON LAKE, WAYNE COUNTY, PENNSYLVANIA, OCTOBER 1986 THROUGH SEPTEMBER 1987.
Geological Survey, Harrisburg, PA. Water Resources Div.
For primary bibliographic entry see Field 5B.
W91-08184

2F. Groundwater

SELF IMPLEMENTED, PRACTICAL GROUND WATER MANAGEMENT PROGRAMS FOR INDUSTRIES.
For primary bibliographic entry see Field 5G.
W91-07172

WATER BALANCE OF A SANDY AQUIFER AT HYDRYLA IN SOUTHERN FINLAND.
R. Lemmela.
Sarja-Ser.A. II. Biologica-Geographica-Geologica 73, 1990. 340p, 49 fig, 13 tab, 90 ref.

Descriptors: *Finland, *Groundwater, *Groundwater budget, *Hydrologic budget, *Sand aquifers, *Surface-groundwater relations, Evaporation, Geohydrology, Groundwater discharge, Infiltration, Lysimetry, Rainfall-runoff relationships, Snow, Soil temperature, Soil water.

A study was performed in order to define which factors determine the amount of infiltration of rainwater and meltwater in an area with conditions typical of groundwater formation and use in southern Finland. The following were measured during 1967-1985: the amounts of rain and snow; evaporation; the infiltration capacity of frozen and unfrozen ground; soil temperature and moisture; the groundwater level; and the physical properties of the soils. A discharge curve for the groundwater could be constructed on the basis of these measurements. The curve, in turn, could be used to evaluate the amount of groundwater formed, the discharge of the groundwater, even for periods shorter than one year. The method was checked against the lysimeter method. It can be used to evaluate the rate of renewal of groundwater resources in sandy aquifers when utilization of water resources is being planned. (Author's abstract)
W91-07196

POTENTIOMETRIC SURFACE OF THE KINGSHILL AQUIFER AND HYDROLOGIC CONDITIONS: ST. CROIX, U.S. VIRGIN ISLANDS, JULY 1987.
Geological Survey, San Juan, PR. Water Resources Div.
Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4085, 1990. 1p, 1 map, 3 ref.

Descriptors: *Groundwater level, *Kingshill Aquifer, *Maps, *Potentiometric surface, *Regional Aquifer System Analysis, *St Croix, *Virgin Islands(US), Groundwater mining, Groundwater quality, Hydrologic data collections, Hydrologic properties, Lithology, Precipitation, Well logs.

A groundwater level survey and reconnaissance of the hydrologic conditions in central Saint Croix were performed during July 1987. This synoptic survey was accomplished as part of the Caribbean Island-Regional Aquifer System Analysis program. This map covers the island's principal groundwater system, the Kingshill aquifer, and areas nearby. The potentiometric surface was delineated on the basis of measurements at existing wells and several test holes which were constructed at sites where lithologic and borehole geophysical data were obtained. The map illustrates existing conditions of the potentiometric surface altitude, the location of most major production wells and their estimated discharge, and sites where groundwater quality samples for common constituents and stable isotopes of water were collected. The map also shows two important hydrologic features: conservation ponds and areas served by the public water supply system from the seawater desalination plant at Christiansted. Hydrologic conditions prevailing within the island have changed since they were addressed in the mid-1960s. Between 1963 and 1967 the average departure of the mean annual precipitation from the long-term normal was -4.96 in., indicative of relatively dry years. For the period of record, 1983 to 1987, this average departure was only -11.41 in., indicating that the annual average precipitation for the period was closer to the average long-term normal of 42 in. Other significant changes are: groundwater withdrawals in the south-central part of the aquifer area increased from < 50,000 gpd (gallons per day) to about 0.5 million gpd, and the dredging of Krause Lagoon for construction of port facilities. Both factors may explain the difference in the potentiometric surface which is as much as 5 ft lower within the south-central part of the aquifer. (Lantz-PTT)
W91-07198

SUPERFUND RECORD OF DECISION, ALLIED CHEMICAL, OH.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
For primary bibliographic entry see Field 5G.
W91-07204

ESTIMATING NET RECHARGE TO THE WATER TABLE IN THE GIRGARRE PROJECT AREA USING HISTORIC PIEZOMETRIC DATA AND LINEAR PROGRAMMING.
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
S. A. Prathapar, and D. Erskine.
Technical Memorandum 90/5, June 1990. 22p, 11 tab, 5 ref.

Descriptors: *Computer programs, *Data interpretation, *Groundwater recharge, *Hydrologic data collections, *Model studies, *Water table, Estimating, Flow discharge, Groundwater movement, Hydraulic head, Mathematical studies, Piezometry.

Net recharge in the Girgarre Project Area, Australia, for a six year period beginning 1983, was determined from historic piezometric data. Initially, monthly net recharge values were determined by a linear programming (LP) model for each element within the project area. Subsequently, 12 consecutive monthly net recharge values of an element were added to obtain the annual net recharge. Annual net recharge values during 1983/88 determined by the LP model implies a perfect match between observed and predicted final heads in all elements during each monthly net recharge estimation. In general, pumped volumes exceed estimated net recharge values during 1983/88. The change in head during a year, storage coefficients and pumped volumes are inconsistent with the hypothesis that recharge/discharge in an element affects only the element considered. Annual estimated net recharges and volumes of water pumped from the project area during 1983/88 show no significant rise in water level in the elements within the project area. The difference between the pumped volume and net recharge in each year indicates the magnitude of recharge in the project area. Annual pumping and discharge values rose from 907.0 Ml in 1983 to 1644.0 Ml in 1988. (Lantz-PTT)
W91-07222

IMPACT OF RESIDENTIAL URBAN AREAS ON GROUNDWATER QUALITY: SWAN COASTAL PLAIN, WESTERN AUSTRALIA.
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
For primary bibliographic entry see Field 4C.
W91-07224

MAJOR GEOHYDROLOGIC UNITS IN AND ADJACENT TO THE OZARK PLATEAUS PROVINCE, MISSOURI, ARKANSAS, KANSAS, AND OKLAHOMA--ST. FRANCOIS CONFINING UNIT.
Geological Survey, Rolla, MO. Water Resources Div.
J. L. Imes.
Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225.

USGS Hydrologic Investigations Atlas HA-711-D, 1990. 3p, 3 maps, 6 ref.

Descriptors: *Geohydrology, *Groundwater movement, *Hydrologic maps, *Regional Aquifer System Analysis, *St Francois Confining Unit, Aquifer systems, Arkansas, Data collections, Kansas, Maps, Missouri, Oklahoma, Ozark Plateau.

An investigation of the geohydrologic system in the Ozark Plateaus province was made as part of the Central Midwest Regional Aquifer System Analysis, a major study of the regional aquifer system in parts of 10 States. The St. Francois confining unit, the lower confining unit in the Ozark Plateaus aquifer system, is composed of Upper Cambrian shale, siltstone, dolostone, and limestone. The thickness of the St. Francois confining unit, as determined from well-log data, ranges from 0 to 730 ft in the Ozark Plateaus province. The maximum thickness occurs in Madison County, Arkansas, and is coincident with a deep depression in the Precambrian surface, and becomes thinner in western Missouri (ranging from about 100 to 300 ft). The St. Francois confining unit retards the flow of groundwater between the more permeable Ozark and St. Francois aquifers. Geologic formations that are considered confining units on a regional scale may have more aquifer-like properties locally where lithologic or structural features increase the formations' hydraulic conductivity. Where the hydraulic conductivity of a confining unit is considerably less than that of the adjacent aquifers, the direction of water movement through the confining unit is nearly vertical and the rate of low is proportional to the hydraulic gradient across the unit. Significant factors that affect the tendency of sedimentary rocks to impede the movement of water include the presence of shale (usually a mostly impermeable material), the rocks' primary permeability, post-depositional development of solution channels, and the presence of fractures and faults. The leakage coefficient is inversely proportional to the thickness of the confining unit; that is, a thicker confining unit is a more effective barrier to groundwater flow. (Lantz-PTT)
W91-07236

GLACIAL HISTORY AND GEOHYDROLOGY OF THE IRONDEQUOIT CREEK VALLEY, MONROE COUNTY, NEW YORK.
Geological Survey, Ithaca, NY. Water Resources Div.
W. M. Kappel, and R. A. Young.
Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4145, 1989. 34p, 13 fig, 5 tab, 3 plates, 17 ref.

Descriptors: *Geohydrology, *Glaciohydrology, *Groundwater movement, *Irondequoit Creek, *New York, Aquifers, Glacial drift, Glacial sediments, Gravel, Groundwater quality, Hydrologic budget, Sand, Water level.

A buried segment of the Pinnacle Hills moraine, which fills the valley beneath the Irondequoit Creek floodplain at Browncroft Boulevard in Rochester, effectively separates the groundwater systems of the southern two-thirds of the Irondequoit Creek basin from that of the northern third. The glacial and post-glacial deposits in the northern (lower) third of the basin consist of variable thicknesses of till and lacustrine sand and silt that interfinger with, and are overlain by, alluvial organic silt and sand. Groundwater within these deposits moves north toward Lake Ontario. The glacial and post-glacial deposits just south (upstream) of the buried moraine sediment consist of mixed sequences of till, fine to coarse sand and gravel, and lacustrine silt overlain by approximately 40 ft of silty, sandy alluvium. Groundwater in this part of the basin moves north toward the buried moraine, and the post-glacial alluvium that overlies the buried moraine is the only significant hydraulic connection between the two groundwater systems. Groundwater levels were measured at the Powder Mills Park fish hatchery in the upper Irondequoit valley and in Ellison Park in the lower valley. Water levels in the upper valley are controlled primarily by precipitation and evapotranspiration. Recent development of the area upgradient from the hatchery seems to have affected groundwater only minimally. Groundwater levels in the lower valley are controlled by the constriction of surface water and groundwater through this postglacial valley section, and the main source of recharge to this area is precipitation. The quality of groundwater in the lower valley appears to be stable along the valley axis but contains elevated chloride concentrations at shallow depths at several locations near the valley walls. Water in deeper parts of the aquifer has not been affected, presumably because it has a slight upward flow component. (Lantz-PTT)
W91-07237

ESTIMATING WATER QUALITY FROM GEOPHYSICAL LOGS.
Geological Survey, Denver, CO. Water Resources Div.
For primary bibliographic entry see Field 7B.
W91-07240

REGIONAL AND LOCAL TENSOR COMPONENTS OF A FRACTURED CARBONATE AQUIFER.
Geological Survey, Doraville, GA. Water Resources Div.
M. L. Maslia.
IN: Rock Mechanics: Proceedings of the 28th U.S. Symposium. June 29-July 1, 1987, Tucson, Arizona. A.A. Balkema, Rotterdam, The Netherlands. 1987. p 441-452, 3 fig, 2 tab, 25 ref.

Descriptors: *Aquifers, *Carbonates, *Data interpretation, *Geohydrology, *Groundwater quality, *Porous media, *Regional Aquifer System Analysis, Aquifer characteristics, Aquifer systems, Floridan Aquifer, Least squares method, Transmissivity.

A methodology is presented for testing the validity of the equivalent porous medium (EPM) approach in a fractured and solutioned carbonate aquifer system. A plot of the square root of directional diffusivity in the direction of the observation well on polar paper, determined from field data, should outline an ellipse. Data from a regional and a local aquifer test of the Floridan aquifer system near Jesup, Ga., show little scatter about a weighted least squares ellipse. Additionally, the geometric mean of regional and local transmissivity, 251,900 and 254,000 sq ft/day, respectively, are in excellent agreement, indicating that the local test data can be extrapolated for use in regional aquifer analyses. In contrast, aquifer test data for the Floridan 40 miles to the southeast near Brunswick, Ga., exhibit much scatter about the weighted least squares ellipse. The regional and local geometric mean of transmissivity, 177,200 and 73,200 sq ft/day, respectively, indicate that local values should not be extrapolated for use in regional aquifer analyses in the Brunswick area. (Author's abstract)
W91-07241

HYDROLOGIC AND GEOCHEMICAL CHARACTERIZATION OF RECHARGE AND GROUNDWATER FLOW IN A RECLAIMED-COAL-MINED LAND, NORTHWESTERN COLORADO.
Geological Survey, Denver, CO.
G. M. Clark, and R. S. Williams.
IN: Fifth Billings Symposium on Disturbed Land Rehabilitation. Volume II: Hazardous Waste Management; Wildlife; Hydrology, Drainages, Erosion and Wetlands; Soils, Minesoils and Overburden; Linear Disturbances; Oil and Gas. March 25-30, 1990. Billings, Montana. Reclamation Research Unit Publication No. 9003, (1990). 173-185, 5 fig, 5 tab, 18 ref.

Descriptors: *Coal mining, *Colorado, *Geochemistry, *Geohydrology, *Groundwater movement, *Groundwater recharge, *Land reclamation, Aquifers, Calcium, Dissolved solids, Environmental effects, Isotope studies, Magnesium, Model studies, Snowmelt, Sulfates, Water table.

Surface coal mining in northwestern Colorado has disturbed large areas of land and the underlying bedrock. During mining, the overburden and coal area removed, and the fragmented overburden (spoil) is placed back into the mine pit. This removal and replacement process can alter the hydrology of the area. At the Seneca Mine, a water table aquifer has formed in the reclaimed coal mined land (RCML), and a spring, which is supplied by the water table aquifer in the RCML, has formed at the base of the reclaimed slope. Hydraulic and isotopic analyses indicate that during 1988, recharge to the aquifer in the RCML was from snowmelt and an underlying underburden aquifer. Mixing calculations based on oxygen and hydrogen isotope analysis from water samples collected in May 1988 indicate that between 53% and 63% of the recharge to the RCML aquifer came from the underburden aquifer. The predominant ions in water samples collected from the aquifer in the RCML and from the associated spring were calcium, magnesium, and sulfate. The dissolved solids concentration was about 2,800 mg/L. Geochemical reaction simulations indicate that gypsum and epsomite are the primary minerals that affect water chemistry in the RCML. These minerals most likely occur as precipitated amorphous efflorescent salts and, prior to reclamation, are formed after the oxidation of pyrite and the dissolution of calcite and dolomite in spoil piles. The reaction model BALANCE indicated three feasible mixing simulations of soil water and underburden aquifer water in which 50% and 59% of the recharge to the aquifer in the RCML were from the underburden aquifer. (Author's abstract)
W91-07242

GEOCHEMISTRY OF THE FLORIDAN AQUIFER SYSTEM IN FLORIDA AND IN PARTS OF GEORGIA, SOUTH CAROLINA, AND ALABAMA.
C. L. Sprinkle.
Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. Regional Aquifer-System Analysis--Floridan Aquifer System. USGS Professional Paper 1403-I, 1989. 105p, 41 fig, 21 tab, 9 maps, 46 ref.

Descriptors: *Florida, *Floridan Aquifer, *Geochemistry, *Groundwater quality, *Regional Aquifer System Analysis, *Water chemistry, Bicarbonates, Calcium, Chlorides, Dissolved solids, Groundwater recharge, Hydrologic data collections, Magnesium, Maps, Sodium, Sulfates.

The chemical quality of the groundwater in the Floridan aquifer system is determined primarily by mineral-water interaction. However, some changes in water quality have been imposed by development, particularly near coastal pumping centers. A total of 601 chemical analyses, all from different wells, most completed in the upper part of the aquifer system, were used to describe the variations in water chemistry and to study the processes responsible for observed changes. The Floridan aquifer system is a vertically continuous sequence of Tertiary carbonate rocks that are of generally high permeability and are hydraulically connected in varying degrees. Dissolved solids concentrations in water from the Upper Floridan aquifer generally range from < 25 mg/L near outcrops to $> 25{,}000$ mg/L along the coasts. The dominant cations in the groundwater are Ca(2+), Mg(2+), and Na(+); the dominant anions are HCO3(-), Cl(-), and SO4(2-). The concentration of Ca(2+) is controlled primarily by calcite saturation. Concentrations of Mg(2+), Na(+), and Cl(-) are highest where mixing of freshwater and saltwater occurs. Concentrations of HCO3(-) reflect the control of calcite solubility. The concentration of SO4(2-) is highest where gypsiferous rock units are present in the aquifer system. The major geochemical processes that occur in the Upper Floridan aquifer, based on water quality maps and computations using a geochemical model are: (1) dissolution of aquifer minerals toward equilibrium; (2) mixing of groundwater with recharge, leakage, or seawater; (3) sulfate reduction; and (4) cation exchange between water and aquifer minerals. (Lantz-PTT)
W91-07244

GROUND-WATER CONDITIONS IN UTAH, SPRING OF 1990.
Geological Survey, Salt Lake City, UT. Water Resources Div.
For primary bibliographic entry see Field 6D.
W91-07246

SUBSURFACE SCIENCE PROGRAM: PROGRAM OVERVIEW AND RESEARCH ABSTRACTS, FY 1989-FY 1990.
Department of Energy, Washington, DC. Office of Energy Research.
For primary bibliographic entry see Field 7C.
W91-07247

MAJOR GEOHYDROLOGIC UNITS IN AND ADJACENT TO THE OZARK PLATEAUS PROVINCE, MISSOURI, ARKANSAS, KANSAS, AND OKLAHOMA--OZARK CONFINING UNIT.
J. L. Imes.
Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Hydrologic Investigations Atlas HA-711-F, 1990. 3p, 3 maps, 3 ref.

Descriptors: *Geohydrology, *Hydrologic data collections, *Maps, *Ozark Plateau, *Regional Aquifer System Analysis, Aquifer systems, Groundwater movement, Hydraulic conductivity, Lithology, Ozark Confining Unit.

An investigation of the geohydrologic system in the Ozark Plateaus province has been made as part of the Central Midwest Regional Aquifer System Analysis, a major study that encompasses parts of 10 States. The Ozark confining unit, the uppermost confining unit in the Ozark Plateaus aquifer system, is composed of a sequence of geologic units that range stratigraphically from the Upper Ordovician, Maquoketa Shale to the Lower Mississippian, Chouteau Limestone. Geologic well log data shows that the thickness of the Ozark confining unit generally ranges from 0 to $>$ 1,500 ft in the Ozark Plateaus province. In most of the province, however, the confining unit is $<$ 120 ft thick and is, therefore, relatively thin in comparison to other geohydrologic units in the Ozark Plateaus province. The semipermeable geologic strata of the Ozark confining unit impedes the movement of groundwater between the overlying Springfield Plateau aquifer and the underlying Ozark aquifer. This sequence of rocks has been identified and named as a confining unit on the basis of its regional hydrologic properties. However, local lithologic and structural variations can increase the confining unit's hydraulic conductivity and cause the layer to have aquifer-like properties. Thus, locally, water may be more easily transmitted through the confining unit, resulting in a greater hydraulic connection between the Springfield Plateau and the Ozark aquifers. (Lantz-PTT)
W91-07252

MODELCARE 90: CALIBRATION AND RELIABILITY IN GROUNDWATER MODELLING.
Proceedings of the Conference held at The Hague, The Netherlands, September 3-6, 1990. International Association of Hydrological Sciences, Washington, DC. 1990. 539p. Edited by Karel Kovar.

Descriptors: *Calibrations, *Data interpretation, *Groundwater movement, *Groundwater transport, *Hydrologic models, *Model studies, *Prediction, *Sensitivity analysis, *Uncertainty, Estimating, Estimating equations, Groundwater, Mathematical studies, Model testing, Simulation, Simulation analysis, Statistical studies.

The usefulness of the predictive simulations obtained by groundwater models is often hampered by the inability to indicate and preferably quantify the reliability of the model results. Uncertainty in model predictions primarily stems from a number of errors relating to the model formulation. In recent years much research has been carried out resulting in a variety of approaches that can be followed to incorporate the information about these errors into the modeling process. Various techniques have been developed to assess the confidence levels of model predictions so that users can account for uncertainties in the decision making process. This volume contains 52 papers spread over six topics into which the conference was organized. These papers were selected by the Scientific Committee from more than 170 abstracts submitted from many countries all over the world. It is believed that this volume contains some outstanding scientific papers and that it presents a state-of-the-art review of the relevant methodologies and techniques and identifies the needs for future developments. (See W91-07253 thru W91-07305) (Author's abstract)
W91-07253

PARAMETER ESTIMATION FOR THE 'VENLOER SCHOLLE' MULTI-AQUIFER SYSTEM USING SUPERCOMPUTERS.
Technische Hochschule Aachen (Germany, F.R.). Inst. fuer Wasserbau.
H. Daniels, B. Romunde, A. Braxein, and G. Rouve.
IN: ModelCARE 90: Calibration and Reliability in Groundwater Modelling. IAHS Publication No. 195. International Association of Hydrological Sciences, Washington, DC. 1990. p 3-12. 10 fig, 12 ref.

Descriptors: *Aquifer systems, *Calibrations, *Computer models, *Groundwater movement, *Model studies, *Model testing, *Parameter estimation, *Supercomputers, Algorithms, Aquifer characteristics, Aquifers, Computer programs, Computers, Costs, Data interpretation, Data processing, Data requirements, Finite element method, Germany, Mathematical analysis, Mathematical studies, Precision.

Parameter estimation for a huge multi-aquifer system is a challenge. It is important to use a fast computer program on a fast machine to achieve good calibration results. The performance of the classical Gauss-Newton plus Line Search (GNLS) algorithm was compared to the performance of the more recently developed Adjoint State Conjugated Gradient (ASCG) algorithms. Both algorithms were implemented into a finite element code for multi-aquifer groundwater flow problems. The global system of algebraic equations was solved using preconditioned conjugated gradients. Calculation of the element matrices as well as assembling of the global coefficient matrix was vectorized and partially done in a preprocessor code. The performance of the vectorized GNLS and ASCG algorithms was demonstrated for a simple test case as well as for the Venloer Scholle multi-aquifer system in Germany in terms of accuracy per unit costs. As a result of many tests performed it was concluded that the ASCG method showed better performance than GNLS for the multi-aquifer test case. It was concluded that the best solution for a problem with many parameters to be estimated may be the use of the less expensive ASCG iterations in the first place to improve the initial guesses. If ASCG convergence slows down, some (i.e., not more than three) more expensive GNLS iterations should be used. If GNLS fails to converge, the problem may be ill posed or infeasible. In this case prior information should be included in the objective function. (See also W91-07253) (Korn-PTT)
W91-07254

OPTIMUM SELECTION OF BASIS FUNCTIONS FOR ILL-POSED INVERSE PROBLEMS.
Australian National Univ., Canberra. Centre for Resource and Environmental Studies.
C. R. Dietrich.
IN: ModelCARE 90: Calibration and Reliability in Groundwater Modelling. IAHS Publication No. 195. International Association of Hydrological Sciences, Washington, DC. 1990. p 13-22. 1 fig, 1 tab, 18 ref.

Descriptors: *Aquifers, *Geostatistics, *Groundwater movement, *Model studies, *Optimization, *Parameterization, *Transmissivity, Aquifer characteristics, Aquifer systems, Calibrations, Geohydrology, Kriging, Linear programming, Mathematical analysis, Mathematical studies, Numerical analysis, Piezometric head, Statistical analysis, Statistical methods.

Solutions to hydrogeological inverse problems can depend on the particular set of basis functions chosen to represent unknown parameters. Therefore, it is important to seek optimum sets. This was illustrated with the inverse problem of two-dimensional aquifer transmissivity estimation from piezometric head data set up in a geostatistical framework. This study used numerical experiments to investigate the specific question of choosing basis functions to represent an unknown distributed parameter in an ill-posed problem. A problem is ill-posed if either the solution does not exist, is not unique, or does not depend continuously on the data. The results of the study revealed that the singular functions of the associated linear operator formed an optimum basis by maximizing the amount of information passed from the solution space to the data space. In addition, it was shown that such functions provided a framework from which the instabilities of ill-posed problems could be investigated in considerable depth. Although extension of the above to non-linear ill-posed problems is not straightforward, it is still possible to use the linear case to provide useful guides insofar as what good basis functions ought to be. When placed in a geostatistical framework, transmissivity identification from head data involved basis functions that naturally possessed good properties. That is, the kriged logtransmissivity expansion was finite, smooth (almost everywhere), and slowly varying. Furthermore, the numerical experiments indicated that the structure of the expansion could be exploited to infer information on unknown parameters through indirect approaches. (See also W91-07253) (Author's abstract)
W91-07255

TEMPORAL AND SPATIAL VARIABILITY OF HYDRAULIC HEADS IN FINITE HETEROGENEOUS AQUIFERS: NUMERICAL MODELLING.
California Univ., Davis. Dept. of Land, Air and Water Resources.
M. M. Hantush, and M. A. Marino.
IN: ModelCARE 90: Calibration and Reliability in Groundwater Modelling. IAHS Publication No. 195. International Association of Hydrological Sciences, Washington, DC. 1990. p 23-31. 4 fig, 10 ref. University of California, Water Resources Center, Water Resources Center Project UCAL-WRC-W-697 and Agricultural Research Service Cooperative Agreement 4940-H.

Descriptors: *Aquifer characteristics, *Finite element method, *Groundwater movement, *Hydraulic head, *Hydrologic models, *Model studies, Approximation method, Aquifer systems, Aquifers, Boundary conditions, Calibrations, Differential equations, Mathematical analysis, Mathematical studies, Numerical analysis, Recharge, Spatial distribution, Stochastic process, Storativity, Temporal distribution, Transmissivity.

The quantification of hydraulic head variability in space and time in a two-dimensional transient groundwater flow was analyzed within the framework of a Galerkin finite-element procedure and an eigenvalue technique. A first-order approximation of the governing stochastic partial differential equation was solved discrete in space and continuous in time. The solution took into account the spatial variability of natural log transmissivity (ln T), natural log storativity (ln S), and random initial conditions. The solution was applied to a hypothetical aquifer subject to effective vertical recharge and with different boundary conditions. The results of the study revealed that the ln T variability induced significant hydraulic head variances in the vicinity of the recharge area and increased in time toward steady state values. However, unlike the no-flow boundary conditions, the results showed the considerable effect of fixed-head boundary conditions on reducing head variances. The variability of the ln S field resulted in short-term but relatively significant head variances (for large variances in ln S). (See also W91-07253) (Korn-PTT)
W91-07256

CALIBRATION OF GROUNDWATER FLOW MODELS USING MONTE CARLO SIMULATIONS AND GEOSTATISTICS.
Calvin Coll., Grand Rapids, MI.
R. J. Hoeksema, and R. B. Clapp.
IN: ModelCARE 90: Calibration and Reliability in Groundwater Modelling. IAHS Publication No. 195. International Association of Hydrological Sciences, Washington, DC. 1990. p 33-42. 2 fig, 11 ref. U. S. Department of Energy Contract No. DE-AC05-84OR21400.

Descriptors: *Calibrations, *Computer models, *Flow models, *Geostatistics, *Groundwater movement, *Hydrologic models, *Model studies, *Monte Carlo method, Aquifer characteristics, Aquifer systems, Finite element method, Hydraulic conductivity, Hydraulic head, Mathematical analysis, Mathematical equations, Mathematical studies, Model testing, Numerical analysis, Recharge, Spatial distribution, Unconfined aquifers.

Groundwater flow models require specification of several input parameter fields which are inferred from limited data. This study describes the application of the geostatistical approach to the problem of calibrating a groundwater flow model. This method used Monte Carlo (MC) simulation to obtain head related covariances and was applied to the particular case of flow in an unconfined aquifer with recharge. As developed in this study, the method predicted both the conductivity field and the recharge rate. Usually point observations of conductivity and head are available for the estimation of conductivity and recharge rate. Use of numerical flow models require that these fields be prescribed as average values over finite elements. The testing of this approach was done using two computer programs. The first program was designed to generate artificial data sets for the testing the method while the second program performed the calibration for both artificially generated data and for real problems. The results of the tests done on artificial aquifer models showed that the method works quite well when compared to using just the mean natural logarithm of the saturated hydraulic conductivity (ln K) value. The quality of the results are based on matching the predicted ln K field with the true field and also on a comparison of the predicted heads to the true heads. The tests done using only two ln K measurements showed that much of the basic ln K variation could be measured from the head data. (See also W91-07253) (Korn-PTT)
W91-07257

CALIBRATION AND RELIABILITY OF AN AQUIFER SYSTEM MODEL USING GENERALIZED SENSITIVITY ANALYSIS.
Australian National Univ., Canberra. Centre for Resource and Environmental Studies.
For primary bibliographic entry see Field 7C.
W91-07258

PARAMETER ESTIMATION FROM ARTIFICIAL TRACER EXPERIMENTS.
Gesellschaft fuer Strahlen- und Umweltforschung m.b.H. Muenchen, Neuherberg (Germany, F.R.). Inst. fuer Hydrologie.
P. Maloszewski, and A. Zuber.
IN: ModelCARE 90: Calibration and Reliability in Groundwater Modelling. IAHS Publication No. 195. International Association of Hydrological Sciences, Washington, DC. 1990. p 53-62. 6 fig,4 tab, 8 ref. Polish Academy of Natural Sciences Grant CPBP 01.03, GF-I-4.

Descriptors: *Aquifer characteristics, *Calibrations, *Dispersion, *Error analysis, *Groundwater movement, *Groundwater transport, *Hydrologic models, *Model studies, *Parameter estimation, *Path of pollutants, *Tracers, Aquifer systems, Aquifers, Boundary conditions, Diffusion, Dispersivity, Experimental data, Flow models, Fracture permeability, Graphical analysis, Mass transport, Mathematical analysis, Mathematical equations, Mathematical studies, Numerical analysis, Porosity.

Tracer experiments are often applied to obtain some aquifer parameters which may serve for the prediction of pollutant movement. The dispersion equation is the most commonly applied general model. Its numerous analytical and numerical solutions represent particular models applicable to situations described by boundary and initial conditions. However, an improperly chosen model of the interpretation of tracer experiments may yield completely false parameters. Another common error in the interpretation of tracer experimental data is caused by using approximate methods for determining such flow parameters as the travel time and the dispersivity. The current study analyzed these two possible sources of errors in terms of conservative solutes for tracer experiments performed in a granular formation and fissured rock. The analysis of different models and interpretation methods applied to the two field tracer experiments showed possible errors in the interpretation of tracer data and in the prediction of pollutant travel. For a prediction in fissured rock, having a high matrix to fissure porosity ratio, the dispersivity was negligible, whereas the diffusion into the matrix is the main phenomena causing a longitudinal spread of solute. (See also W91-07253) (Korn-PTT)
W91-07259

EVALUATION OF SINGLE BOREHOLE HYDROTESTS IN FREQUENCY DOMAIN BY A UNIVARIATE STATISTICAL METHOD.
Stuttgart Univ. (Germany, F.R.). Inst. fuer Wasserbau.
P. Marschall, and B. Barczewski.
IN: ModelCARE 90: Calibration and Reliability in Groundwater Modelling. IAHS Publication No. 195. International Association of Hydrological Sciences, Washington, DC. 1990. p 63-73. 6 fig, 10 ref.

Descriptors: *Aquifer characteristics, *Boreholes, *Data interpretation, *Fracture permeability, *Frequency distribution, *Homogeneity, *Model studies, *Porous media, *Pumping tests, *Statistical methods, *Test wells, *Transmissivity, Analytical methods, Aquifers, Borehole geophysics, Calibrations, Data acquisition, Frequency analysis, Frequency domain method, Groundwater movement, Hydraulic impedance test, Hydraulic properties, Spectral analysis, Statistical analysis, Time series analysis.

Single borehole hydrotests are frequently applied to determine local transmissivity values in porous and fractured media. The analysis of those tests is commonly performed by using analytical time domain solutions corresponding to the homogeneous aquifer. The recently developed frequency domain method allows the analysis of any type of single borehole hydrotest by one single procedure. Data were recorded during a hydraulic impedance test (HIT) in a highly permeable aquifer and on a constant-head test in a low permeable fractured rock. A transfer function was defined which did not depend on initial conditions but only on the geometry and the hydraulic properties of the aquifer. A relation was then derived between the head disturbance in a well and the response of the well-aquifer system during a hydrotest. Based on this concept, a univariate statistical method of spectral analysis was derived which allowed the estimation of smooth transfer functions from a set of several hydrotests performed in the same well. The reliability of the hydrotest data was expressed by the determination of the confidence intervals of the estimated transfer function. The results of analysis of the field data using the frequency domain method were comparable to results which were in accordance with common time domain approaches. (See also W91-07253) (Korn-PTT)
W91-07260

QUICK AND STABLE ALGORITHM FOR GROUNDWATER FLOW PARAMETER ESTIMATION UNDER UNCERTAINTY.
Karlsruhe Univ. (Germany, F.R.). Inst. fuer Hydromechanik.
B. Odenwald, and B. Herrling.
IN: ModelCARE 90: Calibration and Reliability in Groundwater Modelling. IAHS Publication No. 195. International Association of Hydrological Sciences, Washington, DC. 1990. p 75-86. 5 fig, 1 tab, 6 ref. Deutsche Forschungsgemeinschaft (DFG) Grant No. He 1115/3.

Descriptors: *Algorithms, *Groundwater movement, *Model studies, *Optimization, *Parameter estimation, *Uncertainty, Calibrations, Data interpretation, Finite element method, Flow models, Hydrologic models, Mathematical analysis, Mathematical models, Mathematical studies, Model testing, Monte Carlo method, Sensitivity analysis.

A quick and stable algorithm for groundwater parameter estimation has been developed using optimization methods. A combination of gradient, Gauss-Newton and full Newton algorithms were used. The optimization methods were directly connected with the finite element groundwater flow computations. The sensitivity matrix was computed by a differentiation of the discretized flow equation. The gradient and the complete Hessian were computed by an adjoint state method. By formulating the inverse problem as a maximum likelihood parameter estimation problem, it was possible to estimate the parameters as well as quantify the uncertainty associated with the estimates. A two parameters example was used to illustrate the parameter identification procedure. The methodology was applied to a realistic groundwater flow model and Monte Carlo analysis was used to check the results. It was obvious that the mean parameters computed by the Monte Carlo simulation agreed well with the parameters calculated using the algorithm, and the mean estimated standard deviations coincided well with the standard deviations of the parameters from the Monte Carlo simulations. (See also W91-07253) (Author's abstract)
W91-07261

APPLICATION OF AN AUTOMATIC CALIBRATION TECHNIQUE TO MODELLING AN ALLUVIAL AQUIFER.
Universidad Politecnica de Cataluna, Barcelona (Spain). Escuela Tecnica Superior de Ingenieros de Caminos, Canales y Puertos.
J. Samper, J. Carrera, G. Galarza, and A. Medina.
IN: ModelCARE 90: Calibration and Reliability in Groundwater Modelling. IAHS Publication No. 195. International Association of Hydrological Sciences, Washington, DC. 1990. p 87-95. 6 fig, 7 ref. ENRESA Grants TC612 and TC518.

Descriptors: *Alluvial aquifers, *Calibrations, *Hydrologic models, *Mine wastes, *Model studies, *Model testing, *Path of pollutants, *Plumes, *Radioactive wastes, *Solute transport, *Uranium, Aquifer systems, Computer models, Data interpretation, Flow models, Groundwater movement, Groundwater transport, Infiltration, Prediction, Sensitivity analysis, Spain, Uncertainty.

Radioactive solutes have leaked from a Uranium Mill Tailings Pond into an alluvial aquifer located in Southern Spain. Stabilization and closing of the tailings pond require studying the present state and future evolution of the plume. For this purpose a groundwater flow and solute transport model was developed. The modelling approach, based on an automatic calibration technique, involved several stages. First, a conceptual model for groundwater flow and solute transport was formulated using the available data. A sequence of flow models were calibrated using a maximum likelihood based automatic parameter estimation program. While the agreement between measured and computed heads was excellent, the direction of one of the plumes was not properly simulated. During the transport calibration, the structure of the flow model was slightly modified in order to improve the match between measured and computed concentrations. Surprisingly, the final transport parameters were close to their prior estimates, which was believed to be a consequence of the robustness and level of detail of the calibrated flow model. Standard sensitivity and prediction analyses were carried out and the resulting model was deemed safe for use in predicting the future evolution of the uranium migration under different hypotheses. (See also W91-07253) (Author's abstract)
W91-07262

RELIABILITY THEORY AS APPLIED TO ESTIMATION IN CONVERGING VERSUS NON-CONVERGING FLOW FIELDS.
Notre Dame Univ., IN. Dept. of Civil Engineering.
S. Silliman, D. Schmucker, E. Sack, and B. Spencer.
IN: ModelCARE 90: Calibration and Reliability in Groundwater Modelling. IAHS Publication No. 195. International Association of Hydrological Sciences, Washington, DC. 1990. p 97-108. 8 fig, 13 ref. Department of the Interior, U. S. Geological Survey Grant No. 14-08-0001-G1477.

Descriptors: *Data interpretation, *Flow characteristics, *Groundwater movement, *Heterogeneity, *Hydraulic conductivity, *Model studies, *Reliability theory, Calibrations, Computer models, Computer programs, Flow models, Hydrologic models, Mathematical analysis, Mathematical equations, Mathematical studies, Monte Carlo method, Sensitivity analysis, Statistical analysis.

Investigations of variability in groundwater flow and transport have typically focused on heterogeneity in the hydraulic conductivity. Reliability theory and Monte Carlo simulation were utilized to investigate the influence of hydraulic heterogeneity on the distribution of hydraulic head in converging and non-converging flow fields. Sensitivities determined for the non-converging flow field did not show consistent dependence on conductivity in any specific region of the medium. Sensitivity in the converging flow fields was consistently concentrated near the center of the radial coordinate system. Analysis of the limit state surface for a non-converging flow field led to the identification of non-linearities near the design point. These non-linearities may limit the application of reliability theory in one-dimensional and/or converging flow fields. Projected extensions of this work include analysis of transmissivity estimates from pump tests and analysis of chemical tracer tests. (See also W91-07253) (Author's abstract)
W91-07263

IMPROVEMENT OF MODEL PARAMETER IDENTIFICATION IN NUMERICAL COMPUTATION.
Nanjing Univ. (China). Dept. of Earth Sciences.
X. Y. Zhu, G. R. Zhu, and C. H. Xie.
IN: ModelCARE 90: Calibration and Reliability in Groundwater Modelling. IAHS Publication No. 195. International Association of Hydrological Sciences, Washington, DC. 1990. p 109-115. 4 fig, 1 tab, 2 ref.

Descriptors: *Groundwater movement, *Hydraulic head, *Hydrologic models, *Model studies, *Numerical analysis, *Parameter estimation, Boreholes, Calibrations, Computer models, Data acquisition, Data interpretation, Flow models, Heterogeneity, Mathematical analysis, Mathematical equations, Mathematical studies, Observation wells, Prediction, Pump wells, Pumping, Uncertainty.

One source of uncertainty in groundwater model predictions stems from incorrect parameter values. For modeling purposes, the objective is to determine parameters from a limited number of observations of heads in boreholes scattered in the field. The criterion used in this approach is generally the minimization of the difference between observed and calculated heads at these boreholes. The influence of the locations of observation boreholes were examined as well as weight factors on parameter identification in groundwater flow modeling. The results of the investigation revealed that the distance from the observation point to the pumping well as well as the pumping rate and time had an influence on the results of parameter identification. In order to get a correct result, it was determined that observation boreholes should not be placed far from the well field and the groundwater should not be pumped at a low rate or for a short time period. A new method of determining the weight factor in the objective function involved the division of the problem domain into triangles surrounding each observation borehole. This new method proved to be accurate and useful in groundwater modelling. The problem of heterogeneity was also examined in the study. It was determined that, in a heterogeneous region, a zonation approach was the most useful. The use of the zonation approach made it possible to divide the flow region into a number of zones based on hydrogeological mapping. A constant parameter value could then be used to characterize each zone and an estimate of weight factors could be obtained according to the hydrological knowledge. (See also W91-07253) (Korn-PTT)
W91-07264

LINKING GROUNDWATER HYDRAULICS AND OPTIMIZATION IN A SELF-CALIBRATING FINITE DIFFERENCE MODEL.
K.N. Toossi Univ. of Technology, Tehran (Iran). Dept. of Civil Engineering.
K. Zomorodi.
IN: ModelCARE 90: Calibration and Reliability in Groundwater Modelling. IAHS Publication No. 195. International Association of Hydrological Sciences, Washington, DC. 1990. p 117-123. 1 fig, 5 ref.

Descriptors: *Calibrations, *Finite difference methods, *Groundwater movement, *Hydraulics, *Hydrologic models, *Model studies, *Optimization, Computer models, Computer programs, Data acquisition, Data interpretation, Differential equations, Flow models, Geohydrology, Mathematical analysis, Mathematical equations, Mathematical studies, Prediction.

Groundwater model calibration and verification is commonly performed to improve the reliability of the model. Ideally, the groundwater model must have the capability of self-calibration, which means that the value of the calibration parameter must be internally calculated by the model itself. A flexible, self-calibrating groundwater model was developed; this model links groundwater hydraulics and optimization and solves for the optimal values of calibration parameters. The finite difference model was written using the General Algebraic Modeling System (GAMS) language. GAMS is a programming language with an internal compiler which takes the program written by the user and generates a model which can be interpreted and solved by various linear, non-linear, and mixed-integer optimization solvers. Automatic calibration of one or more parameters, or a matrix of values for the calibration parameter is performed in a single model run. A sample model was run to verify various capabilities of the model. The results indicated that the model could accomplish multi-parameter automatic-calibration very efficiently. The model also has the potential to perform all the three phases of model calibration, verification, and prediction. (See also W91-07253) (Korn-PTT)
W91-07265

NUMERICAL METHOD FOR AQUIFER PARAMETER ESTIMATION UTILIZING ENVIRONMENTAL TRACERS IN A TRANSIENT FLOW SYSTEM.
Ben-Gurion Univ. of the Negev, Sde Boker (Israel). Jacob Blaustein Inst. for Desert Research.
E. M. Adar, and S. Sorek.
IN: ModelCARE 90: Calibration and Reliability in Groundwater Modelling. IAHS Publication No. 195. International Association of Hydrological Sciences, Washington, DC. 1990. p 135-148. 5 fig, 6 tab, 20 ref.

Descriptors: *Aquifer characteristics, *Data interpretation, *Environmental tracers, *Flow system, *Groundwater movement, *Groundwater transport, *Mathematical models, *Model studies, *Numerical analysis, *Parameter estimation, Algorithms, Aquifer systems, Calibrations, Hydrologic models, Mathematical analysis, Mathematical equations, Mathematical studies, Optimization, Piezometric head, Storativity, Transmissivity, Water chemistry.

Regional hydrochemistry and environmental isotope data have traditionally been used as an important qualitative tool to help the postulation on groundwater regimes. A mathematical model which utilizes environmental tracers to assess the distribution of transmissivities, storativities, and fluxes into and through an aquifer system has been demonstrated for a compartmental aquifer configuration. The model is based on a lumped parameter approach in which the aquifer is discretized into a finite number of cells. Inflows and transmissivities are evaluated by optimizing a set of mass balance equations expressing conservation of water, isotopes, and dissolved chemicals. Storativities are assessed by implementing the Gauss-Markov optimization approach to periodic changes in piezometric heads. The conceptual model and the computer code were tested with a set of synthetic data which had been generated for a hypothetical aquifer divided into four mixing cells. The test showed that, as long as the data were precise and the number of mass-balance expressions exceeded the number of unknowns, the proposed algorithm was able to correctly estimate flow components and transmissivities across active (i.e., flowing) boundaries. The model has been specifically developed for basins with scarce hydrologic data in which information about environmental tracers is more easily accessible. (See also W91-07253) (Korn-PTT)
W91-07267

ESTIMATION OF TRANSVERSE DISPERSIVITY IN THE MIXING ZONE OF FRESH-SALT GROUNDWATER.
Kyushu Univ., Fukuoka (Japan). Dept. of Civil Engineering.
T. Hosokawa, K. Jinno, and K. Momii.
IN: ModelCARE 90: Calibration and Reliability in Groundwater Modelling. IAHS Publication No. 195. International Association of Hydrological Sciences, Washington, DC. 1990. p 149-158. 7 fig, 5 ref.

Descriptors: *Dispersivity, *Groundwater movement, *Mixing, *Model studies, *Parameter estimation, *Saline water intrusion, *Saline-freshwater interfaces, Aquifer characteristics, Calibrations, Coastal aquifers, Convection, Data interpretation, Dispersion, Flow equations, Flow pattern, Groundwater transport, Mass transport, Mathematical analysis, Mathematical equations, Mathematical studies, Numerical analysis, Simulation analysis, Solute transport, Unconfined aquifers.

Numerical simulations of the salt water intrusion into a coastal aquifer require the information on both longitudinal and transverse dispersivities which characterize the extent of the mixing zone. A method was developed for the estimation of transverse dispersivity in a homogeneous isotropic coastal aquifer where salt water intrusion has taken place and the mixing zone of fresh-salt water can be observed. An approximate solution of the concentration profile in the mixing zone is derived from the simplified convection-dispersion equation in steady-state flow with respect to the curvilinear coordinate system. In this approach, an axis parallel to the fresh-salt water interface is taken as the stream direction. The validity of the proposed method was confirmed through both a laboratory and a field experiment. The numerical solution obtained by the proposed method compared well with the measured profiles obtained in a laboratory experiment. In addition, the results of the numerical simulation of the concentration distribution and flow pattern as derived by the proposed method compared well with results obtained from an unconfined aquifer. (See also W91-07253) (Korn-PTT)
W91-07268

SIMULTANEOUS CALIBRATION OF FLOW AND TRANSPORT MODELS AND OPTIMIZATION OF REMEDIATION MEASURES.
Ecole Nationale des Ingenieurs des Travaux Ruraux et des Techniques Sanitaires, Strasbourg (France).
C. Kauffmann, W. Kinzelbach, and J. J. Fried.
IN: ModelCARE 90: Calibration and Reliability in Groundwater Modelling. IAHS Publication No. 195. International Association of Hydrological Sciences, Washington, DC. 1990. p 159-170. 6 fig, 2 tab, 13 ref.

Descriptors: *Calibrations, *Computer models, *Flow models, *Groundwater transport, *Mass transport, *Model studies, *Optimization, *Site remediation, *Solute transport, Algorithms, Aquifer management, Aquifers, Contamination, Data interpretation, Field tests, Finite element method, Germany, Mathematical studies, Plumes, Pollutants, Sensitivity analysis.

Numerical flow models calibrated on the basis of observed head values are usually not accurate enough to form a reliable basis for transport computations. Removal of the non-uniqueness of flow parameters prevailing in mere flow model calibrations simultaneous calibration of flow and transport parameters was investigated. The usefulness of simultaneous automatic calibration of flow and transport models was illustrated by a field example. A flow and transport finite element model was applied to a field case at a site in the alluvial sand-gravel aquifer of the Upper Rhine valley. The results of the investigation revealed that the procedure allowed improvement in the quality of the flow model by taking into account information on concentrations of pollutants in the plume. In addition, the optimization scheme used in the calibration procedure could also be used as an aquifer management tool. By formulating a suitable objective function, it was possible to show that a unique solution for a remediation well existed which allowed a minimization of both the cost of the operation and the recovery time of the contaminated production wells. However, the quality of this solution depended on the quality of the calibration, but in the example it turned out to be stable under possible fluctuations of future hydrologic conditions. (See also W91-07253) (Korn-PTT)
W91-07269

JOINT KRIGING AND ZONATION APPROACH TO INVERSE GROUNDWATER MODELLING.
Technical Univ. of Denmark, Lyngby.
A. Keidser, D. Rosbjerg, K. Hogh Jensen, and K. Bitsch.
IN: ModelCARE 90: Calibration and Reliability in Groundwater Modelling. IAHS Publication No. 195. International Association of Hydrological Sciences, Washington, DC. 1990. p 171-183. 7 fig, 22 ref.

Descriptors: *Calibrations, *Flow models, *Geostatistics, *Groundwater movement, *Groundwater transport, *Hydrologic models, *Kriging, *Mass transport, *Model studies, *Transmissivity, Computer models, Data acquisition, Data interpretation, Denmark, Flow equations, Least squares method, Mathematical analysis, Mathematical equations, Mathematical studies, Optimization, Plumes, Simulation, Spatial distribution, Statistical analysis, Statistical methods.

A combined kriging and zonation approach for inverse identification of distributed transmissivities was studied. A priori estimation of the transmissivity field was carried out using the kriging method. The methodology introduces correcting terms to the kriging estimates to compensate for noise and scarcity of the kriging observations. The magnitude of the correction is region-specific, but proportional to the kriged standard deviation estimates, thereby retaining the spatial structure of the field inside each zone. The weighting of the prior information is somewhat automatic. The aim of the combined kriging and zonation approach is to utilize all available information about the transmissivity and at the same time introduce a method for a differentiated evaluation and weighting of the information. The estimation of the correcting factors is based on least squares minimization of both head and concentration residuals. The new method was applied to a real-life contamination problem in Denmark where it successfully predicted plume migration that was consistent with available information and observations. By combining the zonation and kriging methods it seems that reliable estimates of spatially distributed transmissivities and transport parameters can be obtained. However, more field testing is required in order to assess the practical applicability of the model in general terms. (See also W91-07253) (Korn-PTT)
W91-07270

INVERSE MODELLING OF COUPLED FLOW AND SOLUTE TRANSPORT PROBLEMS.
Universidad Politecnica de Cataluna, Barcelona (Spain). Escuela Tecnica Superior de Ingenieros de Caminos, Canales y Puertos.
A. Medina, J. Carrera, and G. Galarza.
IN: ModelCARE 90: Calibration and Reliability in Groundwater Modelling. IAHS Publication No. 195. International Association of Hydrological Sciences, Washington, DC. 1990. p 185-194. 2 fig, 1 tab, 19 ref. Empresa Nacional de Residuos Sociedad Anonima (ENRESA) Grant No. TC0612.

Descriptors: *Calibrations, *Computer models, *Flow models, *Groundwater movement, *Model studies, *Solute transport, Adsorption, Algorithms, Data acquisition, Data interpretation, Diffusion, Flow equations, Geostatistics, Mathematical analysis, Mathematical equations, Mathematical studies, Standard deviation, Uncertainty.

The use of concentration data during the calibration of aquifer models was investigated. The consideration of both flow and transport parameters during calibration tends to improve the reliability of results. An algorithm for the estimation of flow and solute transport, including matrix diffusion and adsorption processes, is based on the Maximum Likelihood Estimation theory in which prior information in model parameters can be included. Prior information may come from qualitative sources or geostatistically-based data. Minimization of the objective function is achieved by Gauss-Newton type algorithms which work very well after suitable modifications. The proposed methodology was applied to a synthetic case to illustrate the improvement in the estimation as a result of the combined use of head and concentration data. The results of the investigation revealed that the addition of concentration data improved the results on several counts. The standard deviations were much smaller when concentration data were considered and an even more significant reduction was observed in the true errors of the computed parameters. In addition, the actual errors were more consistent with their standard deviations when concentration data was included. It was concluded that the use of concentration data improved the estimation of model parameters and the validity of uncertainty measurements. While drawbacks arose from the numerical and conceptual difficulties associated with solute transport, it was felt that, in some cases, these problems could be overcome. (See also W91-07253) (Korn-PTT)
W91-07271

USE OF AN AUTOCALIBRATION TO EVALUATE THE CONSISTENCY OF A DATA-SET IN RELATION TO GEOCHEMICAL MODEL FORMULATIONS.
Waterloopkundig Lab. te Delft (Netherlands).
M. R. L. Ouboter, and N. M. De Rooij.
IN: ModelCARE 90: Calibration and Reliability in Groundwater Modelling. IAHS Publication No. 195. International Association of Hydrological Sciences, Washington, DC. 1990. p 195-202. 4 fig, 1 tab, 5 ref.

Descriptors: *Calibrations, *Data collections, *Data interpretation, *Data quality control, *Geochemistry, *Groundwater chemistry, *Groundwater movement, *Model studies, Adsorption, Cation exchange, Chemical interactions, Data acquisition, Equilibrium, Heavy metals, Hydrogen ion concentration, Mathematical analysis, Mathematical equations, Mathematical methods, Mathematical studies, Water quality.

A groundwater system is often characterized by a large chemical complexity. Values of pH, cation exchange capacity, and cationic composition of the exchange complex can vary in time and space. The values of the model parameters controlling cation adsorption seem to be dependent on the system. In many geochemical models, a system definition is derived from a database containing fixed numbers. The modeling of a groundwater system with a database-derived system definition may, in some cases, be impossible. The optimal parameter set should be found before starting the modelling of the groundwater system. To obtain the optimal parameter set, a geochemical model (CHARON) was adapted for an autocalibration application. The principal of autocalibration lies in the minimalization of the differences of calculated and laboratory values. Using a method of autocalibration a parameter set can be derived which is able to represent field data. The method was used to determine the model parameters for two data sets. The results of the model application successfully described the adsorption of heavy metals (i.e., cadmium) to suspended solids in a surface water system by reproducing the measured values in the two data sets. (See also W91-07253) (Author's abstract)
W91-07272

PERCOLATION AND RANDOM WALK MODELS FOR SIMULATING DISPERSION PHENOMENA IN FRACTURE NETWORKS.
Ministry of Agriculture, Tel-Aviv (Israel). Water Commission.
For primary bibliographic entry see Field 5B.
W91-07273

APPROACH TO MODEL TRANSPORT OF CONTAMINANTS INCLUDING GEOCHEMICAL PROCESSES: DEPENDENCE OF SORPTION COEFFICIENTS ON GEOCHEMICAL SURROUNDING.
Technische Univ. Berlin (Germany, F.R.). Inst. fuer Wassergefaehrdende Stoffe.
For primary bibliographic entry see Field 5B.
W91-07275

APPROACH TO PROCESS IDENTIFICATION: APPLICATION TO SOLUTE TRANSPORT THROUGH CLAYS.
Universidad Politecnica de Cataluna, Barcelona (Spain). Escuela Tecnica Superior de Ingenieros de Caminos, Canales y Puertos.
For primary bibliographic entry see Field 2G.
W91-07276

EXPERIMENTAL STUDY OF COUPLED FLOW AND MASS TRANSPORT: A MODEL VALIDATION EXERCISE.
Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands).
For primary bibliographic entry see Field 5B.
W91-07277

EFFECTIVE HYDRAULIC CONDUCTIVITY FOR FRACTURED MEDIA.
Royal Inst. of Tech., Stockholm (Sweden). Dept. of Land and Water Resources.
S. Follin.
IN: ModelCARE 90: Calibration and Reliability in Groundwater Modelling. IAHS Publication No. 195. International Association of Hydrological Sciences, Washington, DC. 1990. p 251-260. 1 tab, 16 ref.

Descriptors: *Fracture permeability, *Geologic fractures, *Groundwater movement, *Hydraulic conductivity, *Mass transport, *Model studies, *Porous media, Calibrations, Data interpretation, Geostatistics, Heterogeneity, Mathematical analysis, Mathematical studies, Monte Carlo method, Standard deviation, Statistical analysis, Statistical methods.

The main object of the theory of flow and mass transport through formations of pronounced heterogeneity is the derivation of the equations satisfied by macroscopic variables. A general problem of groundwater flow and mass transport models in porous or fractured heterogeneous media is the assignment of effective hydraulic conductivity values to model blocks. If the state of nature is basically random, then the effective hydraulic conductivity of each block cannot be described with a deterministic model. Rather, the description must include a measure of the inherent variability and thus uncertainty of the hydraulic conductivity fields at various scales. The current study discusses the use of continuum approximations in modeling concepts for the effective hydraulic conductivity in fractured formations. In the report, only statisti-

cal results were obtained reflecting the inherent variability of the hydraulic conductivity. The results of the study indicated that an increase in the straddle interval decreased the variability in the hydraulic conductivity, though the standard deviation was still being pronounced at a straddle interval of 30 meters. However, since the data were averaged in a very broad manner in order to accomplish data sets at different scales, the derivations of the results disregarded the mixing of different field conditions. (See also W91-07253) (Korn-PTT)
W91-07278

TRANSPORT AND STORAGE PHENOMENA IN A FRACTURE MATRIX SYSTEM: EXPERIMENTAL INVESTIGATIONS AND NUMERICAL MODELLING.
Hanover Univ. (Germany, F.R.). Inst. fuer Wasserwirtschaft, Hydrologie und Landwirtschaftlichen Wasserbau.
R. Mull, and W. Pfingsten.
IN: ModelCARE 90: Calibration and Reliability in Groundwater Modelling. IAHS Publication No. 195. International Association of Hydrological Sciences, Washington, DC. 1990. p 261-269. 6 fig, 1 tab, 9 ref. German Research Foundation Grant No. MU 440/14-1.

Descriptors: *Fracture permeability, *Geological fractures, *Groundwater movement, *Groundwater storage, *Groundwater transport, *Model studies, *Path of pollutants, *Solute transport, Advection, Calibrations, Data interpretation, Diffusion, Experimental data, Flow equations, Germany, Hydraulic gradient, Numerical analysis, Permeability, Pollutants, Risk assessment, Site remediation, Water supply.

Water for the public water supply in Germany is mainly pumped from porous aquifers. However, in some regions groundwater is obtained from aquifers located in fractured rock. The current study is part of a risk analysis and examines transport and storage phenomena in a fracture matrix system through the use of laboratory experiments and numerical models. A source of pollutants was assumed to be active for a certain period of time. The results of the experimental and numerical modeling investigations were in good agreement and revealed that pollutants migrated through the fractures predominantly by advection. From the fracture, the pollutants entered into the porous matrix by diffusion during the loading time. When the source of pollution was eliminated, clean water was assumed to enter into the fractures. Once this occurred the pollutants stored in the matrix returned into the fracture. In spite of remedial action (i.e., elimination of the source of pollution) pollutants were found in the system for a long time. (See also W91-07253) (Korn-PTT)
W91-07279

QUALITY ASSURANCE IN THE DEVELOPMENT AND APPLICATION OF GROUNDWATER MODELS.
Butler Univ., Indianapolis, IN. Holcomb Research Inst.
P. K. M. van der Heijde.
IN: ModelCARE 90: Calibration and Reliability in Groundwater Modelling. IAHS Publication No. 195. International Association of Hydrological Sciences, Washington, DC. 1990. p 271-278. 4 fig, 11 ref. U. S. Environmental Protection Agency Cooperative Agreement No. CR-815363.

Descriptors: *Computer models, *Computer programs, *Hydrologic models, *Model studies, *Model testing, *Quality control, Calibrations, Data interpretation, Groundwater movement, Model validation, Quality assurance.

Groundwater modeling has become an important methodology in support of the planning and decision-making processes involved in groundwater management. A systematic, well-defined and controlled approach to all steps of the model development and application process is essential for its successful use in management. Quality Assurance (QA) provides the mechanisms and framework to ensure that decisions are based on the best available data and modeling-based analysis. The purpose of QA in groundwater modeling is to assure the technically and scientifically adequate execution of all tasks included in the study, and to assure that all modeling-based analysis is verifiable and defensible. Suggested QA procedures for code development and maintenance include the following: (1) documentation of code development (record keeping); (2) verification of program structure and coding; (3) validation of complete software product (model validation); (4) documentation of code characteristics, capabilities, and use; (5) scientific and technical reviews; and (6) administrative auditing. To evaluate groundwater models in a systematic and consistent manner, the International Ground Water Modeling Center (IGWMC) has developed a model testing approach which includes (1) verification by testing against known closed-form (analytical) solutions for highly simplified systems, (2) verification by using complex, synthetic problems specially designed for testing specific types of models, and (3) validation against experimental (field or laboratory) results. (See also W91-07253) (Korn-PTT)
W91-07280

SETTING CALIBRATION TARGETS AND ASSESSING MODEL CALIBRATION-ROOM FOR IMPROVEMENT: AN EXAMPLE FROM NORTH AMERICA.
Montana Univ., Missoula. Dept. of Geology.
W. W. Woessner, and M. P. Anderson.
IN: ModelCARE 90: Calibration and Reliability in Groundwater Modelling. IAHS Publication No. 195. International Association of Hydrological Sciences, Washington, DC. 1990. p 279-288. 2 fig, 3 tab, 14 ref.

Descriptors: *Calibrations, *Error analysis, *Flow models, *Hydrologic models, *Model studies, *Model testing, Data interpretation, Errors, Groundwater movement, Hydrologic budget, Nevada, Simulation, Spatial distribution, Water level.

Most field-based flow modeling studies that solve the forward problem inadequately assess model calibration. This deficiency is attributed to the absence of clearly stated calibration targets and a failure to assess the level of calibration achieved. Lumped parameters which typically are used to describe model calibration, give no indication of the spatial variability of calibration results, and should not be used as the only demonstration of model calibration. Calibration targets were defined to be the error associated with selected calibration values which could include heads, fluxes and/or water balances. The case study used to illustrate the setting and assessment of calibration targets involved the use of a three-layer groundwater flow model (MODFLOW) to determine the effect of large scale withdrawal from a hydrologically closed basin in central Nevada. Calibration assessments were standardized by reporting levels of calibration based on targets set prior to simulation. The targets typically were a set of field-measured water levels (heads) and associated measurements and interpolation errors. The number and spatial distribution of calibration nodes were required for each calibration target. The definition of a series of calibration levels allowed the modeler to quantify the magnitude of the deviation of the simulated values from the targets set prior to calibration. A display of calibration levels in map form allowed a rapid assessment of the degree to which the simulated values matched the targets and showed the spatial distribution of calibration results. (See also W91-07253) (Korn-PTT)
W91-07281

CALIBRATION OF GROUNDWATER MODELS FOR THE GRIMSEL UNDERGROUND ROCK LABORATORY, SWITZERLAND.
Colenco Ltd., Baden (Switzerland).
P. Adank, W. Huerlimann, and S. Vomvoris.
IN: ModelCARE 90: Calibration and Reliability in Groundwater Modelling. IAHS Publication No. 195. International Association of Hydrological Sciences, Washington, DC. 1990. p 291-299. 5 fig, 5 ref.

Descriptors: *Calibrations, *Flow models, *Geological fractures, *Groundwater movement, *Hydrologic models, *Model studies, *Radioactive waste disposal, Boundary conditions, Case studies, Data interpretation, Flow around objects, Flow rates, Granites, Grimsel Test Site, Hydraulic gradient, Hydrologic budget, Optimization, Switzerland, Three-dimensional model, Transmissivity, Water pressure.

Since 1983 the Swiss National Cooperative for the Storage of Radioactive Waste (NAGRA) has been conducting in situ experiments at the Grimsel Test Site (GTS) in central Switzerland in the area of movement of groundwater in fractured granitic rock. Three-dimensional modeling of groundwater flow at the GTS drives the development of methodologies and tools used to calibrate and validate site-specific hydrodynamic models. A strategy for calibration was developed using both observed flow rates into the underground structures and measured hydraulic potential values in different boreholes drilled from the laboratory tunnels. The calibration procedure consisted of the identification of a local minimum of head and flux residuals. The limitation of the relevant hydraulic input parameters to three variables (i.e., two transmissivities and the water pressure at the model boundary) made it possible to keep the number of parameter variations low and allowed visualization of the results. The identification of the absolute minimum of the residuals would need a much greater range of parameter variation and would be facilitated with an automatic optimization procedure. The evaluation of the objective function has shown that the reliability of data measurements play an important role. It is important, therefore, that all measurements contain a quantitative evaluation of their reliability in the form of a deviation range. The water balance in the model region provided a very powerful measure that enabled adjustment of the calculated flow of each run and thus verification of the plausibility of the input parameters. (See also W91-07253) (Korn-PTT)
W91-07282

REDUCING GROUNDWATER FLOW MODEL UNCERTAINTIES AT YUCCA MOUNTAIN.
Weston (Roy F.), Inc., Washington, DC.
K. A. Albrecht, D. F. Fenster, and S. G. van Camp.
IN: ModelCARE 90: Calibration and Reliability in Groundwater Modelling. IAHS Publication No. 195. International Association of Hydrological Sciences, Washington, DC. 1990. p 301-309. 1 fig, 9 ref. Department of Energy Contract No. DE-AC01-87-RW00060.

Descriptors: *Flow models, *Groundwater movement, *Hydrologic models, *Model studies, *Model testing, *Nevada, *Radioactive waste disposal, *Uncertainty, *Yucca Mountain Site, Aeration zone, Calibrations, Case studies, Data acquisition, Data collections, Data interpretation, Field tests, Groundwater barriers, Hydrologic regime, Performance evaluation, Quality control, Saturation zone.

The U. S. Department of Energy plans to characterize the Yucca Mountain site in southern Nevada to determine its suitability as a geologic repository for spent nuclear fuel and high-level radioactive waste disposal. This project is unique in its spatial and temporal scales and stringent quality assurance requirements. Site and regional scale areas are on the order of 100 and 10000 sq km, respectively. Performance objectives to meet federal regulations include pre-waste emplacement groundwater travel times (GWTT) from the repository to the accessible environment exceeding 1000 years and limits on cumulative radionuclide releases over a 10000 year period. The current conceptual model of the hydrologic system at Yucca Mountain is composed of unsaturated zone and saturated zone elements. The unsaturated zone is hypothesized to be the principal hydrologic barrier due to low fluxes and large thickness, hence providing long groundwater travel times. Plans for reducing uncertainties in groundwater flow models include obtaining parameter values needed to evaluate alternative conceptual models. Large-scale field tests

are planned at the soil surface, in deep dry-drilled and cored boreholes and underground at the proposed repository depth. These tests will provide parameter value ranges and uncertainties, which will be used as input to performance assessment models. Performance assessment modeling results will, in turn, guide additional data collection activities. (See also W91-07253) (Author's abstract)
W91-07283

RELIABILITY OF A GROUNDWATER MODEL: THE HISTORY OF MODELLING THE JWANENG NORTHERN WELLFIELD IN BOTSWANA.
Anglo American Corp. of South Africa Ltd., Marshalltown.
M. C. Brook.
IN: ModelCARE 90: Calibration and Reliability in Groundwater Modelling. IAHS Publication No. 195. International Association of Hydrological Sciences, Washington, DC. 1990. p 311-319. 8 fig, 12 ref.

Descriptors: *Botswana, *Groundwater management, *Groundwater movement, *Hydrologic models, *Model studies, *Model testing, *Well fields, Calibrations, Case studies, Data interpretation, Drawdown, Finite difference methods, Isotope studies, Recharge, Storage, Three-dimensional model, Water resources management, Wells.

The Jwaneng Northern Wellfield covers, within its present perimeter, an area of some 200 sq km and is situated 55 km north-west of the Jwaneng Diamond Mine, on the fringes of the Kalahari Desert in the Kweneng District of south-eastern Botswana. At the time of the wellfield's inception, a two-dimensional finite difference model was developed to aid long term groundwater resources management. This model has over estimated maximum regional drawdowns in the wellfield center by a factor of five and as a consequence, the model was restructured and recalibrated in 1984. The recalebrated model has overestimated the same drawdowns by 80%. Estimates based on a new hydrogeologic model which incorporates isotope data, indicate significant local recharge to the wellfield. A simple analytical model of wellfield behavior shows that this calculated recharge rate brings the modelled drawdowns into the range of actually observed values. With the current expansion of the wellfield now completed to allow for a maximum monthly abstraction of over 100000 cu m, a more detailed, three-dimensional finite difference model is now available and has replaced all previous models as a long term groundwater management tool. (See also W91-07253) (Author's abstract)
W91-07284

PERSPECTIVE ON NON-UNIQUENESS IN THREE-DIMENSIONAL TRANSPORT SIMULATIONS OF BIODEGRADING ORGANIC CONTAMINANTS.
Waterloo Univ. (Ontario). Inst. for Ground Water Research.
For primary bibliographic entry see Field 5B.
W91-07287

DELINEATION OF GROUNDWATER PROTECTION ZONES USING FORCED GRADIENT TRACER TESTS: A MODEL VALIDATION CASE STUDY.
Stuttgart Univ. (Germany, F.R.). Inst. fuer Wasserbau.
G. Teutsch, and B. Hofmann.
IN: ModelCARE 90: Calibration and Reliability in Groundwater Modelling. IAHS Publication No. 195. International Association of Hydrological Sciences, Washington, DC. 1990. p 351-360. 8 fig, 2 tab, 3 ref.

Descriptors: *Groundwater movement, *Groundwater protection, *Model studies, *Model testing, *Tracers, Calibrations, Case studies, Data interpretation, Finite difference methods, Finite element method, Germany, Groundwater depletion, Groundwater management, Hydraulic conductivity, Permeameters, Pumping tests, Sieve analysis, Storativity, Three-dimensional model, Water quality.

In many European countries, the general approach towards groundwater protection employs some type of zoning system, either based on travel-time or travel-distance contours, or a combination of both. In Germany, the system comprises four protection zones, characterized by various restrictions on activities potentially threatening the groundwater quality. In a study of a planned wellfield in the Rhine valley near Karlsruhe, the project objectives are the prediction of the local and regional groundwater level decline and the delineation of protection ZONE II (i.e., covering an area within the 50 days travel-time contour). The delineation of the ZONE II area was accomplished by comparing results calculated from a large scale hydraulic test with data obtained from a forced gradient tracer test. Predictions of groundwater flow and transport within the anticipated protection zone were carried out using a local scale, three-dimensional model which was linked to a two-dimensional regional model. The results of the investigation demonstrated that transport predictions based on hydraulic data could be far off from reality, even in an aquifer environment of limited heterogeneity. In addition, the model calculations based on parameters obtained from standard pumping test interpretation and sieve analysis produced similar results. For the presented case study, the ZONE II area estimates differed by more than 100%, depending on the type of data used. Therefore, for the calculation of protection zone areas, a conservative approach with a large safety margin was recommended. (See also W91-07253) (Korn-PTT)
W91-07288

MODEL UNCERTAINTIES IN THE SIMULATION OF RIVER MARECCHIA ALLUVIAL FAN (NORTHERN ITALY).
Bologna Univ. (Italy). Ist. di Costruzioni Idrauliche.
A. Bizzarri, and M. Ferraresi.
IN: ModelCARE 90: Calibration and Reliability in Groundwater Modelling. IAHS Publication No. 195. International Association of Hydrological Sciences, Washington, DC. 1990. p 363-372. 4 fig, 1 tab, 5 ref. National Public Education Ministry Grant No. MPI 8903002.

Descriptors: *Alluvial aquifers, *Alluvial fans, *Hydrologic models, *Italy, *Model studies, *Simulation, *Uncertainty, Aquifer characteristics, Aquifers, Calibrations, Data interpretation, Error analysis, Groundwater transport, Hydraulic conductivity, Mathematical analysis, Mathematical equations, Mathematical studies, Piezometric head, Probabilistic process, Sensitivity analysis, Water quality.

The alluvial fan of the Marecchia River in Northern Italy represents the most important water resource in an area where the average annual rainfall is comparatively low and the hydrological regime of the natural watercourses is irregular. Modelling of the aquifer system is hindered by a lack of information concerning aquifer structure, natural boundary conditions, and the rate of contaminant injection. In order to overcome the difficulties and uncertainties arising from the paucity of field data in the alluvial fan of the Marecchia River. which affects both groundwater quantity and quality, identification and calibration procedures followed a conservative approach. The concept of conjunction of states of information was applied to progressively more detailed analyses of the physical system. The results of the study showed that the set-up of a conceptual model for underdetermined problems could not be substituted by probabilistic computations. However, the use of identification procedures provided valuable support in the analysis of the goodness of some initial estimates and in the detection of their consistency with the a priori information on the aquifer system. The model uncertainties could be analyzed and reduced through the numerical exploration of the parameter space, particularly if these procedures were computationally simple. (See also W91-07253) (Korn-PTT)
W91-07289

VELOCITY PREDICTION ERRORS RELATED TO FLOW MODEL CALIBRATION UNCERTAINTY.
Geraghty and Miller, Inc., Reston, VA.
G. M. Duffield, D. R. Buss, and D. E. Stephenson.
IN: ModelCARE 90: Calibration and Reliability in Groundwater Modelling. IAHS Publication No. 195. International Association of Hydrological Sciences, Washington, DC. 1990. p 397-406. 7 fig, 15 ref. U. S. Department of Energy Contract No. DE-AC09-76R00001 (now Contract No. DE-AC09-88SR18035).

Descriptors: *Calibrations, *Error analysis, *Flow models, *Flow velocity, *Groundwater movement, *Model studies, *Uncertainty, Aquifer systems, Data interpretation, Flow equations, Geologic formations, Geologic units, Heterogeneity, Hydraulic conductivity, Numerical analysis, Savannah River Plant, Sensitivity analysis, Spatial distribution, Standard deviation, Three-dimensional model, Water level.

At the Savannah River Site (SRS) in South Carolina, a three-dimensional, steady-state numerical model has been developed for a four aquifer, three aquitard groundwater flow system. While groundwater velocity prediction has been recognized as an important calibration parameter, flow models typically rely upon measured water levels. Using the same set of water-level calibration targets, two separate calibrations of the SRS groundwater flow model produced nearly identical realizations of the hydraulic conductivity field in terms of residual standard deviation (RSD) and flow balance calculations. However, these calibrations did not predict groundwater velocities near a seepage basin facility accurately enough to reproduce observed groundwater travel times to a nearby surface stream. A new representation of the geologic framework was developed during the recalibration of the model with a different set of water levels exhibiting better spatial coverage and density. This calibration produced an improved RSD and better estimates of groundwater travel times in the vicinity of the seepage basins. Thus, the combined use of geologic information and water levels alone were insufficient to produce a calibrated model suitable for analyzing groundwater flow directions and rates in this aquifer system. It was the combined use of three types of information: hydraulic head distributions, geologic framework models, and velocity field monitoring, that provided valuable calibration data for the flow modeling investigations. (See also W91-07253) (Korn-PTT)
W91-07292

SIMULATION OF BLOCK PERMEABILITIES CONDITIONED UPON DATA MEASURED AT A DIFFERENT SCALE.
Stanford Univ., CA. Dept. of Applied Earth Sciences.
J. J. Gomez-Hernandez.
IN: ModelCARE 90: Calibration and Reliability in Groundwater Modelling. IAHS Publication No. 195. International Association of Hydrological Sciences, Washington, DC. 1990. p 407-416. 5 fig, 9 ref.

Descriptors: *Flow models, *Hydrologic models, *Model studies, *Permeability, *Scale factors, *Simulation analysis, Algorithms, Anisotropy, Aquifer characteristics, Calibrations, Data interpretation, Maps, Mathematical analysis, Mathematical studies, Probabilistic process, Sensitivity analysis, Spatial distribution, Statistical analysis, Statistical methods, Statistical models, Stochastic process, Uncertainty.

To provide a probabilistic evaluation of aquifer performance a large number of flow simulations is required using alternative stochastic aquifer images that honor the data values and characteristics of spatial variability. For computational costs, these flow simulations cannot be carried out at the core scale. Therefore, the aquifer images must be coarsened into larger blocks, with average (effective) parameters assigned to blocks. A methodology was developed for generating maps of grid-block permeabilities as input to a numerical flow simulator. The procedure includes an algorithm for upscaling permeability that accounts for the tensorial character of interface permeabilities and reproduces well the fluxes observed at the microscale. This upscal-

ing algorithm is shown to give better results than more traditional techniques. Following this initial step, synthetic training images of interface permeability tensors are used to infer a statistical model for the spatial variability of the permeability tensor and its joint variability with core permeability. The variograms inferred from the training images were found to be well-behaved, and the anisotropy ratio between the principal components of the permeability tensors was found to be almost constant. These statistical models for the block permeabilities allow for their stochastic imaging through equally likely maps of interface permeability tensors conditioned to core data. (See also W91-07253) (Korn-PTT)
W91-07293

REEVALUATION OF LARGE-SCALE DISPERSIVITIES FOR A WASTE CHLORIDE PLUME: EFFECTS OF TRANSIENT FLOW.
Geological Survey, Reston, VA.
For primary bibliographic entry see Field 5B.
W91-07294

GEOSTATISTICAL ASSESSMENT OF NUMERICALLY SIMULATED GROUNDWATER FLOW IN THE UPPER CHICOT AQUIFER NEAR PORT ARTHUR, TEXAS.
INTERA, Inc., Austin, TX.
A. Haug, R. H. Petrini, G. E. Grisak, and K. Klahsen.
IN: ModelCARE 90: Calibration and Reliability in Groundwater Modelling. IAHS Publication No. 195. International Association of Hydrological Sciences, Washington, DC. 1990. p 427-437. 10 fig, 1 tab, 7 ref.

Descriptors: *Aquifer characteristics, *Flow models, *Geostatistics, *Groundwater movement, *Hydrologic models, *Mathematical models, *Model studies, *Model testing, *Simulation, *Texas, Calibrations, Data collections, Data interpretation, Finite difference methods, Flow characteristics, Flow velocity, Hydraulic conductivity, Kriging, Landfills, Mass transport, Sensitivity analysis, Solute transport, Spatial distribution, Statistical methods, Three-dimensional model, Uncertainty, Velocity, Water level, Wells.

A geostatistical analysis was performed to assess direction, magnitude and uncertainty of groundwater flow at a landfill facility near Port Arthur, Texas. The basis of the study was monthly water level data from the uppermost transmissive zone underlying the site. The monthly water levels were obtained over a period of more than five years from about 100 monitoring wells. Generalized kriging and jackknife tests were used to estimate the data uncertainty. Multiple sampling with replacement from the water-level data combined with the data uncertainty resulted in average groundwater velocity vectors for future time periods and in the corresponding confidence intervals. The results were used to designate upgradient and downgradient monitoring wells for regulatory purposes. A comparison was made of these calculated results with the results obtained from a flow model simulation of the site. The particular model used was a three-dimensional finite-difference flow and transport code called SWIFT II. The comparison of the calculated and the simulated flow field revealed that the simulated flow field did not fully reflect the complexity of the real flow field. In addition, the simulated flow direction was representative only in some parts of the model area and the simulated flow velocities were generally too small. However, most of the simulated flow velocities appeared to have the right order of magnitude. Generally speaking, a substantially more complex numerical model which may have to feature complicated boundary conditions, localized recharge, and heterogeneous aquifer parameters would be necessary to obtain a substantially better representation of the hydrogeological system at the Port Arthur landfill facility. (See also W91-07253) (Korn-PTT)
W91-07295

REGIONALIZATION OF HYDRAULIC AQUIFER PROPERTIES-OPTIMIZATION BY GEOSTATISTICAL SIMULATION TECHNIQUES.
Freie Univ. Berlin (Germany, F.R.). Inst. fuer Angewandte Geologie.
M. T. Schafmeister-Spierling, and A. Pekdeger.
IN: ModelCARE 90: Calibration and Reliability in Groundwater Modelling. IAHS Publication No. 195. International Association of Hydrological Sciences, Washington, DC. 1990. p 447-455. 5 fig, 2 tab, 12 ref.

Descriptors: *Aquifer characteristics, *Data interpretation, *Geostatistics, *Hydraulic conductivity, *Hydraulic properties, *Model studies, *Model testing, *Optimization, *Regional analysis, *Simulation, Calibrations, Correlation analysis, Dispersion, Dispersivity, Flow velocity, Germany, Groundwater movement, Heterogeneity, Histograms, Mass transport, Sensitivity analysis, Solute transport, Statistical analysis, Statistical methods, Uncertainty, Variability.

Based on the knowledge of the spatial correlation structure (i.e., histogram and variogram) of the hydraulic conductivity, a geostatistical simulation technique can generate numerous equally-likely realizations of the spatial distribution of hydraulic conductivity which reflect the actual small-scale variability. These realizations can then be inserted into a deterministic model in order to describe the dispersive behavior of an aquifer in a more realistic way. Hydraulic conductivity values for a test site in northern Germany were geostatistically analyzed in order to describe the spatial structure of this flow governing parameter. These values were then inserted in a deterministic transport model where calculated dispersivities ranged between 0.022 and 0.089 m. A total of 15 realizations proved to be sufficient to provide a realistic description of possible extreme flow and transport conditions. The results of the investigation revealed that a significant spatial variability in the hydraulic conductivity distribution could be observed. In addition, it was concluded that the geostatistical simulation method was a cost saving method that was superior to other generally applied regionalization techniques (e.g., linear interpolation). (See also W91-07253) (Korn-PTT)
W91-07297

APPLICATION OF THE RELATIONSHIP BETWEEN SMALL-SCALE AND LARGE-SCALE PERMEABILITIES TO FLUID FLOW MODELLING.
Technische Hogeschool Delft (Netherlands). Dept. of Mining and Petroleum Engineering.
J. M. T. Stam, W. Zijl, J. C. van Dam, and A. K. Turner.
IN: ModelCARE 90: Calibration and Reliability in Groundwater Modelling. IAHS Publication No. 195. International Association of Hydrological Sciences, Washington, DC. 1990. p 457-466. 4 fig, 3 tab, 7 ref.

Descriptors: *Flow models, *Flow pattern, *Fluid flow, *Groundwater movement, *Model studies, *Model testing, *Permeability, *Scale factors, Anisotropy, Calibrations, Darcys law, Data interpretation, Heterogeneity, Infiltration, Mathematical equations, Mathematical studies, Numerical analysis, Porous media, Seepage, Sensitivity analysis, Uncertainty.

Calculation of flow patterns in porous media are based on the fundamental laws of continuous media, or on equations derived from them like the continuity equation and Darcy's Law. The fundamental equations contain parameters that describe the state of the porous medium. Although powerful numerical and mathematical techniques exist to compute fluid flow, it is practically impossible to apply these techniques to solve the small-scale flow pattern. The application of field-scale intrinsic permeabilities calculated from a continuous two-dimensional distribution of small-scale parameters of a sedimentary succession obtained from an alluvial simulation model was studied. The two-dimensional domain consisted of a lower impervious boundary, water divides at the left and right boundaries, and a cosine form potential causing a fluid flow through the upper boundary. The results of the investigation revealed that accurate computations could be made by using the small-scale distribution of permeabilities in the direction of stratification. Small-scale permeabilities perpendicular to the direction of stratification could then be calculated from the former with the help of the field-scale anisotropy. In addition, the heterogeneity of the upper part of the domain determined the amount of flow through the surface as well as the areas where infiltration and seepage occurred. A small-scale modeling of heterogeneity of the top layers was sufficient to calculate the fluid flow through the surface of the domain. The rest of the domain could then be modeled with field-scale permeabilities. (See also W91-07253) (Korn-PTT)
W91-07298

KALMAN FILTER APPROACH TO THE QUANTIFICATION OF THE RELIABILITY OF A GROUNDWATER MODEL.
Institute of Applied Geoscience TNO, Delft (Netherlands).
F. C. van Geer, and C. B. M. te Stroet.
IN: ModelCARE 90: Calibration and Reliability in Groundwater Modelling. IAHS Publication No. 195. International Association of Hydrological Sciences, Washington, DC. 1990. p 467-476. 7 fig, 1 tab, 7 ref.

Descriptors: *Algorithms, *Calibrations, *Data interpretation, *Groundwater movement, *Hydrologic models, *Kalman filtering, *Model studies, *Model testing, *Sensitivity analysis, *Uncertainty, Correlation analysis, Mathematical analysis, Mathematical equations, Mathematical studies, Prediction, Statistical analysis, Statistical methods, Water level.

Deterministic models are widely used to describe the behavior of the groundwater head in time and space. Generally, the procedure of modeling starts from a first estimate of the parameters and driving force based on field measurement (e.g., pumping rates). These parameters are then calibrated with the help of groundwater head measurements. Following calibration, the model results usually differ from reality. However, this deterministic approach can be improved by the use of a Kalman filter algorithm. The Kalman filter algorithm is based on an implicit calculation scheme where, at each time step, the prediction from the deterministic model is updated with the difference between the measurements and the predictions. This update gives better initial conditions for the next time step and therefore the predictions will be better than without using the measurements in the calculation scheme. The present study examines the use of Kalman filtering for assessing the reliability of a deterministic groundwater model and updating model results for a hypothetical example and a real world case. The results of the study indicated that, for slow reacting systems, the use of Kalman filtering proved to be a better tool for calibration than deterministic modelling because of its smaller variance and time dependency. The Kalman filter algorithm technique could also update modelling results because actual measurements were used during and after calibrations. In addition, the reliability could be quantified by the covariance matrix of the optimal estimates as obtained from the differences between the calculated and the observed heads. (See also W91-07253) (Korn-PTT)
W91-07299

BAYESIAN ESTIMATION OF WATER LEVELS.
Orange Free State Univ., Bloemfontein (South Africa). Inst. for Groundwater Studies.
G. J. van Tonder, J. F. Botha, and D. J. De Waal.
IN: ModelCARE 90: Calibration and Reliability in Groundwater Modelling. IAHS Publication No. 195. International Association of Hydrological Sciences, Washington, DC. 1990. p 477-486. 4 fig, 1 tab, 12 ref.

Descriptors: *Aquifer characteristics, *Bayesian analysis, *Data interpretation, *Geostatistics, *Groundwater level, *Mathematical analysis, *Model studies, *Statistical methods, *Water level, Boreholes, Calibrations, Geohydrology, Groundwater data, Kriging, Mathematical equations,

Mathematical studies, Sensitivity analysis, South Africa, Statistical analysis, Transmissivity, Uncertainty.

The inclusion of prior information in the estimation of a set of parameters or variables is a well-known procedure in mathematical statistics commonly referred to as Bayesian analysis. A semi-variogram was used in the analysis of groundwater levels in the Dewetsdorp aquifer in South Africa. To illustrate the Bayesian procedure, use was made of the water levels observed in 72 boreholes drilled as part of a study on natural recharge in the Dewetsdorp aquifer. Fifteen of the boreholes were selected as references for evaluating the behavior of the Bayesian procedure in extrapolation. Using data on water levels and collar heights from the remaining 57 boreholes, a semi-variogram was derived and later used to estimate the water level for the 15 reference boreholes. These estimates, in addition to estimates of water levels obtained using universal kriging were compared with the true water level values for the Dewetsdorp aquifer. The results of the comparison revealed that the Bayes estimates were generally more favorable and did not show the wild fluctuations observed in the corresponding kriging estimates. However, the results do not imply that the Bayesian method is generally superior to kriging. One area that requires more attention is the establishment of suitable qualified guesses for the variables generally encountered in geostatistics. (See also W91-07253) (Korn-PTT)
W91-07300

SEQUENTIAL APPROACH TO GROUNDWATER MONITORING AND MANAGEMENT.
Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.
For primary bibliographic entry see Field 4B.
W91-07301

STOCHASTIC MODELLING OF SOLUTE TRANSPORT IN GROUNDWATER: APPLICATION TO A FIELD TRACER TEST.
Florida Univ., Gainesville. Dept. of Agricultural Engineering.
W. D. Graham, and D. McLaughlin.
IN: ModelCARE 90: Calibration and Reliability in Groundwater Modelling. IAHS Publication No. 195. International Association of Hydrological Sciences, Washington, DC. 1990. p 501-510. 6 fig, 1 tab, 13 ref.

Descriptors: *Field tests, *Flow models, *Groundwater movement, *Hydrologic models, *Model studies, *Path of pollutants, *Plumes, *Solute transport, *Stochastic models, *Stochastic process, *Tracers, Aquifers, Bayesian analysis, Calibrations, Camp Borden Site, Canada, Chlorides, Data interpretation, Geohydrology, Heterogeneity, Mathematical analysis, Mathematical studies, Ontario, Prediction, Standard deviation, Statistical analysis, Statistical methods, Uncertainty, Velocity distribution.

Field data from a large-scale natural gradient test site in Borden, Ontario, have been used to evaluate stochastic theories of subsurface transport. A two-dimensional stochastic transport model was used in predicting the trajectory of a chloride tracer plume at the Borden site. The model provides a convenient method for predicting the movement of solute plumes in heterogeneous aquifers where hydrogeological properties are unknown or highly uncertain. Predictions of the Borden solute plume were conditioned on vertically-averaged concentration at three times. The conditioning process transformed the regularly shaped plumes obtained from unconditional predictions into more realistic irregular plumes using the Bayesian concepts of measurement conditioning. The results of the investigation revealed that the unconditioned mean plumes were quite successful in predicting the peak concentration and average spreading of the actual tracer plumes. However, there was still significant uncertainty associated with the mean prediction which was estimated accurately by the unconditional concentration standard deviation. Some improvement in model prediction was achieved by conditioning the concentration moments using a small subset of the available concentration observations. However, the somewhat limited improvement demonstrated by the conditioned moments indicates that the key to the conditioning process is the definition of the site-specific spatial variability of the groundwater velocity field. (See also W91-07253) (Korn-PTT)
W91-07302

STOCHASTIC ANALYSIS OF UNSTEADY GROUNDWATER HEAD-FIELD IN HETEROGENEOUS REGION, BASED ON PHYSICAL PRINCIPLES.
Nagoya Univ. (Japan). Dept. of Civil Engineering.
M. Harada, and F. Takagi.
IN: ModelCARE 90: Calibration and Reliability in Groundwater Modelling. IAHS Publication No. 195. International Association of Hydrological Sciences, Washington, DC. 1990. p 511-520. 9 fig, 5 ref.

Descriptors: *Aquifers, *Geostatistics, *Groundwater movement, *Hydraulic head, *Hydrologic models, *Model studies, *Rainfall, *Statistical analysis, *Statistical methods, *Stochastic process, *Water level, Aeration zone, Aquifer properties, Calibrations, Data interpretation, Error analysis, Heterogeneity, Japan, Kriging, Mathematical analysis, Mathematical equations, Mathematical studies, Physical properties, Prediction, Rainfall infiltration, Rainfall penetration, Regional analysis, Spatial distribution, Temporal distribution, Uncertainty, Unconfined aquifers, Unsteady flow, Water table, Water table fluctuations.

To analyze regional groundwater behavior, it is important to evaluate the actual spatial and temporal distributions of the hydraulic head obtained from observational data. A stochastic evaluation of the uncertainty associated with groundwater behavior in the unconfined, heterogeneous region of an aquifer as a result of heavy rainfall was carried out for the diluvial aquifer in the Nobi Plain in central Japan. The behavior of the unconfined head-field was investigated by combining statistical concepts and physical properties. The head variance, which statistically expressed the spatial randomness of the water table response to a rainfall, was formulated with the aid of flow properties in the unsaturated zone and in the aquifer. Through the evaluation of the head variance, it was demonstrated that the head-field had greater randomness of spatial distribution in the silty aquifer than in the sandy aquifer. The unsteady head variogram following a rainfall was formulated by evaluating the random component of head due to the heterogeneity of the flow region based on the physical laws of groundwater. The variogram was derived by a perturbation expansion and the spatial head distributions during the recession process were estimated from a limited set of data points using a geostatistical approach. As a result of a kriging estimation in the practical region, it was clarified that, although the estimation error of head-field was very large just after the rainfall, the error decreased during a dry period. This indicated that the estimation accuracy of the field gradually improved. (See also W91-07253) (Korn-PTT)
W91-07303

NETWORK GEOMETRY AND SPATIAL UNCERTAINTY IN GROUNDWATER SOLUTE TRANSPORT MODELLING.
Universitaet fuer Bodenkultur, Vienna (Austria). Inst. fuer Wasserwirtchaft.
H. P. Nachtnebel, and A. Bardossy.
IN: ModelCARE 90: Calibration and Reliability in Groundwater Modelling. IAHS Publication No. 195. International Association of Hydrological Sciences, Washington, DC. 1990. p 529-539. 4 fig, 1 tab, 15 ref. Austrian Academy of Sciences Grant No. HOE 37.

Descriptors: *Groundwater movement, *Model studies, *Network design, *Nitrates, *Nutrient transport, *Path of pollutants, *Solute transport, *Uncertainty, Austria, Boundary conditions, Calibrations, Case studies, Convection, Data interpretation, Dispersion, Geostatistics, Hydraulic conductivity, Kriging, Mathematical analysis, Mathematical equations, Mathematical studies, Prediction, Saturation zone, Sensitivity analysis, Simulation, Spatial distribution, Statistical analysis, Statistical methods, Water level.

The physical process described by a convection-dispersion equation is based on initial and boundary conditions as well as on the spatial distribution of various parameters such as hydraulic conductivity, saturated thickness, and bottom layer. The spatial uncertainty in the output of a solute transport model and the relationship between uncertainty and the observation network for hydraulic parameters were analyzed. The methodology was applied to the unsteady nitrate transport in a small groundwater system in southern Austria. A two-dimensional convection-dispersion solute transport model was modified to obtain the nitrate output for each node and every time step. Based on the assumption that the heads, the saturated thickness and the log of the hydraulic conductivity were realizations of intrinsic functions, the parameters were estimated from measurements by kriging techniques. Conditional simulation was applied to generate a large number of parameter sets which were utilized as an input for the transport model. The estimation variance in the corresponding model output reflected both the randomness of the parameters and the effect of the locations in the observation network. Based on the results of the study it appeared that the heads which entered the model via the boundary values were the most important source of uncertainty while the saturated thickness was the least important source. Therefore, it was suggested that improvements in nitrate concentration forecasts would require additional observations of the heads (boundary conditions). (See also W91-07253) (Korn-PTT)
W91-07305

GROUNDWATER FLOW IN THE BASHITA-MINATO MANGROVE AREA, AND ITS INFLUENCE ON WATER AND BOTTOM MUD PROPERTIES.
Tokai Univ., Shizouka (Japan). Faculty of Marine Science and Technology.
For primary bibliographic entry see Field 2L.
W91-07315

EFFECT OF SOIL PROPERTIES ON UNSATURATED HYDRAULIC CONDUCTIVITY PORE-INTERACTION FACTORS.
North Dakota State Water Commission, Bismarck.
For primary bibliographic entry see Field 2G.
W91-07336

ACETONITRILE AND ACRYLONITRILE SORPTION ON MONTMORILLONITE FROM BINARY AND TERNARY AQUEOUS SOLUTIONS.
Delaware Agriculture Experiment Station, Newark.
For primary bibliographic entry see Field 5B.
W91-07343

AGRICULTURE AND WATER QUALITY: OLD PROBLEM, NEW URGENCY.
Florida Univ., Gainesville. Dept. of Food and Resource Economics.
For primary bibliographic entry see Field 5B.
W91-07361

LOGIC PROGRAMMING IN GROUNDWATER RESOURCES MANAGEMENT.
Bari Univ. (Italy). Ist. di Scienze dell'Informazione.
F. Tangorra, and M. Vurro.
Hydrological Sciences Journal HSJODN, Vol. 36, No. 1, p 1-10, February 1991. 4 fig, 20 ref.

Descriptors: *Artificial intelligence, *Computer models, *Computer programs, *Groundwater management, *Groundwater resources, *Model studies, *Resources management, *Water resources management, Geohydrology, Geologic control, Groundwater quality, Hydrologic models, Italy, Water resources development.

Artificial intelligence techniques can be used to solve problems using a heuristic approach. A model has been developed which is able to verify whether there is groundwater in a given place, the quantity available and its quality. The system has been implemented in the logic programming language Prolog and runs on a personal computer under MS-DOS. The knowledge base has been constructed using degrees of certainty and other factors, and requires the implementation of a user interface that allows queries to be addressed to the knowledge base. The model was applied to a region in Southern Italy, where data are available and groundwater is a very important resource. The entire zone was divided into four subzones according to geology, and the observation wells were assigned to these subzones. The first factor of certainty for finding water was computed as a function of the well/area ratio and the number of wells in the same zone. The second factor of certainty was computed by analyzing the stratigraphy of the sample: by correlating these characteristics with the discovery of water this second factor was also computed. A weighting factor was also assigned on the basis of the thickness of each rock. These parameters were used to answer the first question in the Subject Domain section. The first results are encouraging and further questions about groundwater quantity and quality are being examined. (Fish-PTT)
W91-07623

RHYTHMIC KARST SPRINGS.
Split Univ. (Yugoslavia). Faculty of Civil Engineering Sciences.
O. Bonacci, and D. Bojanic.
Hydrological Sciences Journal HSJODN, Vol. 36, No. 1, p 35-47, February 1991. 9 fig, 8 ref.

Descriptors: *Cavern flow, *Groundwater movement, *Hydrographs, *Intermittent springs, *Karst hydrology, *Model studies, *Surface-groundwater relations, Caves, Groundwater reservoirs, Siphons, Underground streams, Yugoslavia.

Rhythmic springs (ebb and flow springs, intermittent springs, potajnice) belong to the group of springs which appear exclusively in karstified terrains. These springs function by a siphon system, whereby, when the water level in a cave rises to the maximum elevation of the outflow channel, all the water suddenly outflows. A mathematical model has been developed for the functioning of this type of springs based on the principle of recharge and emptying of the underground reservoir through siphon action. This model was applied to three rhythmic springs in Yugoslavia to simulate the functioning of the underground reservoir located in the karst, through hydrographs defined by measurement. The first rhythmic karst spring examined is typical, with a continuous inflow and continual rhythmic recharge filling of the reservoir and emptying through the siphon. The second spring studied belongs to the group of seasonal rhythmic springs in the dry period. During the rainy period of the year it becomes an intensive karst spring without significant oscillations in its discharge. The third spring studied is a special rhythmic spring which consists of two openings 2 m apart. During high groundwater levels, the lower spring functions continually as a rhythmic spring with regular intervals. During the dry periods, the lower spring operates rhythmically, whereas the upper spring dries up for several days or more, and then has the characteristics of a periodic spring. The parameters are determined b the position of the reservoir and the siphon, and by the numerical requirements for an agreement between the observed and simulated hydrographs. The model showed that it can be widely applied: thus it can be concluded with high reliability that the model displays the general characteristics of a real system. (Fish-PTT)
W91-07626

EVALUATION OF THE RESPONSE OF A WATER TABLE TO A VARIABLE RECHARGE RATE.
K.N. Toossi Univ. of Technology, Tehran (Iran). Dept. of Civil Engineering.
K. Zomorodi.
Hydrological Sciences Journal HSJODN, Vol. 36, No. 1, p 67-78, February 1991. 6 fig, 29 ref.

Descriptors: *Artificial recharge, *Groundwater recharge, *Model studies, *Numerical analysis, *Surface-groundwater relations, *Water table fluctuations, Aeration zone, Infiltration rate, Iran, Mathematical models, Model testing, Water table rise.

A new method of evaluation of the response of a water table to artificial recharge has been developed. The solution is formulated in the form of a simple numerical model. The model has several advantages over the traditional methods of mounding prediction. The effect of the unsaturated zone, which modifies the recharge rate as compared with the infiltration rate, is considered. Mounding is calculated for a variable recharge rate induced by a variable infiltration rate. Also, the effect of intransit water in reducing the fillable pore space above a rising water table is considered. The validity of the model results was illustrated using several sets of field data collected in the Ghazvin Plain in Iran. Sample calculations proved that the model predicts mounding more accurately than the traditional methods and, therefore, more realistic recommendations for the design and operation of artificial recharge schemes are possible using the model. (Author's abstract)
W91-07628

REGULATING THE POLLUTION OF GROUND WATER: RESPONDING TO THE NPDES DISCHARGE TO GROUND WATER PERMIT FEE REGULATIONS.
Integrated Data Technologies, Inc., Philadelphia, PA.
W. A. Huber, and R. N. Sands.
IN: Hazardous and Industrial Wastes: Proceedings of the 22nd Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 13-30. 6 fig, 12 ref.

Descriptors: *Effluent charges, *Groundwater pollution, *New Jersey, *Permits, *Regulations, *Wastewater disposal, Environmental impact, Environmental protection, Fees, Groundwater management, Hazardous wastes, Industrial wastes, Water pollution.

The New Jersey Pollutant Discharge Elimination System is a program administered by the State Department of Environmental Protection to regulate the discharge of pollutants to the surface and ground waters of the state. Part of this program is to assess an annual permit fee. Assessment of permit fees for discharges to surface water has been in force since 1981. Permit fees based on discharges to groundwater were first assessed in 1988-1989. The discharge to groundwater permit fees are assessed and recomputed annually. Each fee is the sum of a minimum fee, which is fixed by the facility's fee category, and a net fee, which is directly proportional to an environmental impact. The minimum fees range from $500 for facilities not required to conduct groundwater monitoring to $20,000 for hazardous waste facilities and industrial waste management facilities. The Department of Environmental Protection claims that the fees are structured to encourage more facilities to initiate groundwater remediation. The strength of new 1990 regulation and fee calculation formulas include providing facilities with more incentives to understand and remediate groundwater, and a more equitable distribution of the fee burden among permittees. The analysis has shown that, by reducing the range of possible status factors that multiply the environmental impact, the new formula results in a narrower range of environmental impacts. For the subpopulation of large-environmental impact permittees (those in compliance monitoring or corrective action) this range is about four orders of magnitude, resulting in significant environmental impact-based fees for many. Other states are beginning to follow New Jersey's lead in assessing permit fees for groundwater pollution. (See also W91-07662) (Mertz-PTT)
W91-07663

APPLICATION OF THE SELF-POTENTIAL METHOD TO GROUNDWATER MONITORING.
Pennsylvania Dept. of Environmental Resources, Harrisburg.
Y. M. Reznik.
IN: Hazardous and Industrial Wastes: Proceedings of the 22nd Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 118-126. 5 fig, 4 ref.

Descriptors: *Electrical studies, *Geophysical surveys, *Groundwater monitoring, *Resistivity, *Self potential method, *Subsurface mapping, Electrical properties, Feasibility studies, Geohydrology, Hydrologic data, Streaming potential method.

Geophysical investigations are commonly recognized methods of quick and relatively low-cost evaluation of the site geological and hydrological conditions. Magnetometer, gravimetric, seismic, and electric surveys are considered as the basic methods of geophysical investigations. The electrical resistivity survey is the most popular modification of electrical methods adopted by engineers and geologists for the better understanding of the field information. The streaming potential method is a modification of the Self-Potential method that studies the DC voltage distribution in the earth as a result of numerous electrochemical reactions between different minerals and/or fluids, thermoelectric effects originating naturally (magma) or artificially (underground fires), or reflect electrokinetic effects. The observed streaming (electrofiltration) potentials are generated in the earth due to the movement of a liquid through the solid media and constitute only one type of self-potentials. The geophysical survey programs developed for the selected sites comprised the evaluation of actual field conditions and types of deposited/disposed soils/fills; the determination of electric potential disturbances at the sites of interest; the search for the most effective ways of separation of non-time variant electric potential sources from the time dependent sources; the search for the most rational, productive and accurate way of the field exploration; and the development of independent sets of data for verification of the obtained field readings. These minimum requirements were met at two researched coal refuse disposal facilities where the method of streaming potentials was used. Utilization of the streaming potential method as a convenient tool for the detection and mapping of groundwater paths is very promising. The streaming potential method reflects an existing system of easily detected natural sources of energy and does not require any additional input of force/energy to successfully accomplish its investigative purpose. (See also W91-07662) (Mertz-PTT)
W91-07671

GROUNDWATER DEGRADATION AT A HAZARDOUS WASTE LANDFILL FROM INADEQUATE WASTE LIQUIDS MANAGEMENT--A CASE HISTORY.
Du Pont Environmental Remediation Services, Aston, PA.
For primary bibliographic entry see Field 5B.
W91-07677

MAJOR REMEDIATION: REMOVAL AND RECOVERY OF TCE FROM SOIL AND GROUNDWATER.
Dames and Moore, Willow Grove, PA.
For primary bibliographic entry see Field 5G.
W91-07683

POTENTIOMETRIC SURFACE OF THE ALLUVIAL AQUIFER AND HYDROLOGIC CONDITIONS NEAR CAGUAS, PUERTO RICO, MARCH 1988.
Geological Survey, San Juan, PR. Water Resources Div.
J. C. Puig, F. Rodriguez-del-Rio, and J. M. Rodgriguez.
Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 89-

4075, 1989. 1p, 1 fig, 1 map.

Descriptors: *Alluvial aquifers, *Caguas, *Geohydrology, *Groundwater level, *Hydrologic maps, *Maps, *Potentiometric surface, *Puerto Rico, Aquifers, Groundwater discharge, Groundwater movement, Rio Bairoa, Rio Caguitas, Rio Grande de Loiza, Rio Turabo.

The Caguas alluvial aquifer is a water table system composed of interconnected clay, sand, and gravel layers. The alluvial deposits overlay igneous rock formations. The thickness of the alluvial deposits ranges from < 1 m to about 50 m. A survey of hydrologic conditions was conducted on March 25, 1988. The objective of the survey was to simultaneously obtain hydrologic data that included: groundwater level measurements at wells under static conditions; estimates of groundwater withdrawal rates; and instantaneous discharge measurements at selected sites along the principal streams. The survey was conducted during low flow conditions. Water table level contours represent a two-dimensional approximation of the more complex aquifer system. Also shown on the map is the direction of regional groundwater flow. Streamflow measurements indicate a substantial surface water groundwater relation in the alluvial aquifer. Generally, the streams seems to be receiving water from the aquifer in the upper reaches, but losing water to the aquifer in the lower reaches. In Rio Grande de loiza, Rio Turabo, Rio Caguitas, and Rio Bairoa the net effect is an increase in discharge of about 0.44 cu m/sec. Total groundwater withdrawal rate was estimated at 1.1 million L/day. (Author's abstract)
W91-07810

PHYSICAL AND CHEMICAL CHARACTERISTICS OF TOPOGRAPHICALLY AFFECTED AIRFLOW IN AN OPEN BOREHOLE AT YUCCA MOUNTAIN, NEVADA.
Geological Survey, Reston, VA.
For primary bibliographic entry see Field 2K.
W91-07813

CHANGING EMPHASIS OF THE U.S. GEOLOGICAL SURVEY ACTIVITIES IN GROUNDWATER HYDROLOGY IN THE 1980'S.
Geological Survey, Reston, VA.
For primary bibliographic entry see Field 6B.
W91-07814

DATA MANAGEMENT PROGRAM PACKAGE FOR AUTOMATICALLY RECORDED WATER LEVEL DATA.
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
For primary bibliographic entry see Field 7C.
W91-07817

ESTIMATION OF THE RECHARGE AREA CONTRIBUTING WATER TO A PUMPED WELL IN A GLACIAL-DRIFT, RIVER-VALLEY AQUIFER.
D. J. Morrissey.
Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Water-Supply Paper 2338, 1989. 41p, 31 fig, 5 tab, 53 ref.

Descriptors: *Geohydrology, *Glacial aquifers, *Groundwater movement, *Groundwater recharge, *Groundwater resources, *Model studies, Groundwater quality, Hydraulic conductivity, Hydrologic models, Permeability, Precipitation, Pump wells, Simulation analysis.

The highly permeable unconfined, glacial-drift aquifers that occupy most New England river valleys constitute the principal source of drinking water for many of the communities that obtain part or all of their public water supply from groundwater. To protect the quality of water pumped from supply wells in these aquifers, it is necessary to ensure that potentially harmful contaminants do not enter the ground in the area that contributes water to the well. A high degree of protection can be achieved through the application of appropriate land use controls within the contributing area. However, the contributing areas for most supply wells are not known. This report describes the factors that affect the size and shape of contributing areas to public supply wells and evaluates several methods that may be used to delineate contributing areas of wells in glacial drift, river valley aquifers. Analytical, two-dimensional numerical, and three-dimensional numerical models were used to delineate contributing areas. In the model analyses, factors that control the size and shape of a contributing area were varied over ranges of values common to glacial drift aquifers in New England. The controlling factors include the rate of well discharge, rate of recharge to the aquifer from precipitation and from adjacent till and bedrock uplands, distance of a pumping well from a stream or other potential source of induced recharge, degree of hydraulic connection of the aquifer with a stream, horizontal hydraulic conductivity of the aquifer, ratio of horizontal to vertical hydraulic conductivity, and degree of well penetration. Simulations done with the three-dimensional model allow a full three-dimensional delineation of the zone of contribution for a pumped well. For the relatively thin (100 ft or less) unconfined aquifers considered in this analysis, the three-dimensional model showed that the zone of contribution extended throughout the entire saturated thickness of aquifer; therefore, the two-dimensional simulations were considered adequate for delineating contributing areas in this particular hydrologic setting. For thicker aquifers, especially those having partially penetrating wells, three-dimensional models are preferable. (Lantz-PTT)
W91-07820

EFFECTS OF AGRICULTURE ON QUALITY OF WATER IN SURFICIAL SAND-PLAIN AQUIFERS IN DOUGLAS, KANDIYOHI, POPE, AND STEARNS COUNTIES, MINNESOTA.
Geological Survey, St. Paul, MN. Water Resources Div.
For primary bibliographic entry see Field 4C.
W91-07821

HYDROLOGY OF A SPRING COMPLEX, STUDIED BY GEOCHEMICAL TIME-SERIES DATA, ACQUAROSSA, SWITZERLAND.
Weizmann Inst. of Science, Rehovoth (Israel). Geoisotope Group.
E. Mazor, and F. D. Vuataz.
Applied Geochemistry APPGEY, Vol. 5, No. 5/6, p 563-569, September/December 1990. 5 fig, 2 tab, 4 ref.

Descriptors: *Environmental chemistry, *Geochemistry, *Geohydrology, *Groundwater chemistry, *Groundwater movement, *Mixing, *Springs, *Switzerland, *Time series analysis, Bicarbonates, Case studies, Chlorides, Deuterium, Discharge measurement, Groundwater, Groundwater quality, Hydrologic properties, Hydrology, Oxygen isotopes, Salinity, Sodium, Sulfates, Temperature effects, Tritium.

Single measurements of groundwater systems do not adequately describe their dynamic nature, and provide sporadic and limited insight into groundwater systems. Mixing of water types is common in nature and a crucial stage in the study of a groundwater system is to establish whether one deals with one type of water or with a mixture of waters from different reservoirs. A case study of three springs in Switzerland was used to demonstrate the value of geochemical time-series data as a powerful tool for studying the dynamics of groundwater systems. Values of repeatedly measured parameters revealed intermixing of two water types. One type was a 29 C water, circulating to a depth of approximately 1100 m. Chemical analysis of this water revealed the following constituents: 700 mg/L Ca, 2000 mg/L SO4, 700 mg/L HCO3, 20 mg/L of Na and Cl, 6 mg/L Fe, at least 47 mg/L SiO2, and an isotopic composition of delta-D=-73.0 ppm and delta-18-O=-10.9 ppm. The second water type had a temperature of 12 C or colder and was more shallow. Chemical analysis of this water revealed a total dissolved ion (TDI) content of < or = 420 mg/L. In addition, the water was very low in Na and Cl (i.e., < or = 4 mg/L) and had isotopic values of delta-D=-71.0 ppm and delta-18-O=-10.5 ppm. The amount of tritium present was consistent with recent (i.e., post-bomb) precipitation. These results demonstrate that, because of this mixing of waters, time-series data are essential to the understanding of water systems. (Korn-PTT)
W91-07829

SOURCES AND FRACTIONATION PROCESSES INFLUENCING THE ISOTOPIC DISTRIBUTION OF H, O, AND C IN THE LONG VALLEY HYDROTHERMAL SYSTEM, CALIFORNIA, U.S.A.
Geological Survey, Menlo Park, CA.
A. F. White, M. L. Peterson, H. Wollenberg, and S. Flexser.
Applied Geochemistry APPGEY, Vol. 5, No. 5/6, p 571-585, September/December 1990. 11 fig, 4 tab, 42 ref.

Descriptors: *California, *Chemical properties, *Geochemistry, *Geothermal resources, *Geothermal water, *Groundwater chemistry, *Groundwater movement, *Hydrothermal studies, *Hydrothermal system, *Isotope studies, Carbon isotopes, Environmental chemistry, Groundwater recharge, Hydrogen isotopes, Oxygen isotopes.

The isotopic ratios of H, O, and C in water within the Long Valley caldera, California, reflect input from sources external to the hydrothermal reservoir. A decrease in delta-D in precipitation of 0.5 ppm/km, from west to east across Long Valley, is caused by the introduction of less fractionated marine moisture through a low elevation embayment in the Sierra Nevada Mountain Range. Relative to seasonal fluctuations in precipitation (-135 to -35 ppm), delta-D ranges in hot and cold surface and groundwaters are much less variable (-135 to -105 ppm). Only winter and spring moisture, reflecting higher precipitation rates with lighter isotopic signatures, recharge the hydrologic system. The hydrothermal fluids are mixtures of isotopically heavy recharge (delta-D = -115 ppm, delta-18O = -15 ppm) derived from the Mammoth embayment, and isotopically lighter cold water (delta-D = -135 ppm, delta-18O = -18 ppm). This cold water is not representative of current local recharge. The delta-13-C values for dissolved carbon in hot water are significantly heavier (-7 to -3 ppm) than in cold water (-18 to -10 ppm) denoting a separate hydrothermal origin. These delta-13-C values overlie the range generally attributed to magmatic degassing of CO2. However, delta 13C values of metamorphosed Paleozoic basement carbonates surrounding Long Valley fall in a similar range, indicating that hydrothermal decarbonization reactions are a probable source of CO2. The delta-13-C and delta-18-O values of secondary travertine and vein calcite indicate respective fractionation with CO2 and H2O at temperatures approximating current hydrothermal conditions. (Author's abstract)
W91-07830

PRELIMINARY GEOCHEMICAL AND THERMODYNAMIC ASSESSMENT OF THE GEOTHERMAL RESOURCES, SULPHUR SPRINGS AREA, ST. LUCIA, W.I.
Consiglio Nazionale delle Ricerche, Pisa (Italy). Ist. Internazionale per le Ricerche Geotermiche.
F. D'Amore, J. R. Rivera, D. Giusti, and R. Rossi.
Applied Geochemistry APPGEY, Vol. 5, No. 5/6, p 587-604, September/December 1990. 11 fig, 9 tab, 42 ref.

Descriptors: *Geothermal resources, *Geothermal studies, *Geothermal water, *Groundwater chemistry, *Groundwater mining, *St Lucia, Groundwater, Groundwater resources, Lithology, Steam, Sulphur Springs, Water resources development, Water temperature.

A high-temperature geothermal resource has been located on the island of St. Lucia (W.I.), which was tapped by means of a well drilled in 1988 to a total depth of 1410 m, in the Sulphur Springs area. The well encountered mainly dacitic agglomerates

and lava flows and a permeable zone below approximately 1340 m, with a maximum temperature of approximately 290 C. Well productivity decreased from an initial value close to 62 t/h to about 33 t/h under well-head pressures of 1.5 MPa (15 bar a) after 255 h of production. Initial reservoir static pressure was 7.5 MPa (75 bar a). A decline in reservoir pressure of about 15% was observed at the end of the production test. During the first two days of exploitation the well initially produced a two-phase fluid with a high steam fraction, which then developed into superheated steam with a high content of non-condensable gas exceeding 100 l/kg at standard conditions and a computed P(CO2) of 1 MPa (10 bar). The average steam fraction at reservoir conditions, computed from gas composition after 120 h of production, is approximately 0.3. High HCl concentrations of about 300 ppm are present in the condensate steam indicating the presence of a highly concentrated boiling brine approaching the point of halite saturation. All data support the hypothesis that a hydrothermal hot-water system was present prior to drilling, and that a very rapid drawdown occurred with production. (Author's abstract)
W91-07831

RADIUM ISOTOPES, ALKALINE EARTH DIAGENESIS, AND AGE DETERMINATION OF TRAVERTINE FROM MAMMOTH HOT SPRINGS, WYOMING, U.S.A.
Argonne National Lab., IL.
For primary bibliographic entry see Field 2K.
W91-07832

CARBOXYLIC ACID ANIONS IN FORMATION WATERS, SAN JOAQUIN BASIN AND LOUISIANA GULF COAST, U.S.A.--IMPLICATIONS FOR CLASTIC DIAGENESIS.
Wyoming Univ., Laramie. Enhanced Oil Recovery Inst.
D. B. MacGowan, and R. C. Surdam.
Applied Geochemistry APPGEY, Vol. 5, No. 5/6, p 687-701, September/December 1990. 5 fig, 6 tab, 95 ref, 1 append.

Descriptors: *Anions, *Carbonates, *Carboxylic acid, *Chemical interactions, *Diagenesis, *Formation water, *Geochemistry, *Groundwater chemistry, *San Joaquin Valley, Alkalinity, Aluminum, California, Carboxylation, Chemical analysis, Groundwater, Hydrocarbons, Hydrogen ion concentration, Model studies, Oxidation-reduction potential, Sandstones, Shales, Silica, Silicates.

Carboxylic acid anions (CAA) in formation waters are of interest to studies of clastic diagenesis because of their ability to buffer formation water Eh and pH. In addition, CAA are also of interest because of their ability to complex and transport Al and Si from the site of aluminosilicate mineral dissolution during diagenesis. In the present study a total of 40 formation waters from the San Joaquin Basin, California, and the Louisiana Gulf Coastal Basin were analyzed for their CAA contents. The results of the investigation revealed concentrations as high as 8100 ppm monofunctional and 370 ppm difunctional CAA in the formation waters. These results suggest that CAA were generated during thermal maturation of kerogen and expelled from the shale along oil-wet microfractures. Upon entering the water-wet sandstone pore, the hydrophilic CAA would partition into the aqueous phase. In addition, organic-inorganic reactions could occur which form CAA-metal complexes. Because the complexes are hydrophobic, they would partition in the petroleum phase, where present. CAA are of great importance to clastic diagenesis over the temperature range in which they dominate fluid alkalinity; certainly, no viable mechanism has been advanced which adequately explains the observed aluminosilicate mineral dissolution with subsequent mass transfer of Al, as well as the carbonate mineral diagenetic succession observed in sand-shale systems worldwide. The utility of modeling these observations of organic-inorganic diagenesis is limited only by the ability to model the concentration and distribution of CAA through space and time. (Author's abstract)
W91-07833

HYDROGEOCHEMISTRY AND STABLE ISOTOPES OF GROUND AND SURFACE WATERS FROM TWO ADJACENT CLOSED BASINS, ATACAMA DESERT, NORTHERN CHILE.
McGill Univ., Montreal (Quebec). Dept. of Geological Science.
C. N. Alpers, and D. O. Whittemore.
Applied Geochemistry APPGEY, Vol. 5, No. 5/6, p 719-734, September/December 1990. 11 fig, 3 tab, 79 ref.

Descriptors: *Atacama, *Chemical composition, *Chemical interactions, *Chile, *Closed basins, *Environmental chemistry, *Geochemistry, *Groundwater chemistry, *Isotope studies, *Surface water, *Water chemistry, Chemical analysis, Chlorides, Copper, Deuterium, Dissolution, Groundwater, Groundwater recharge, Metamorphic water, Meteoric water, Mixing, Oxygen radioisotopes, Salts, Weathering.

To determine the origin of waters and dissolved components in two closed basins, a total of 24 water samples were obtained from the Hamburgo and Punta Negra Basins in the Atacama Desert region of northern Chile. Results of the study revealed that the groundwaters in the Hamburgo and Punta Negra Basins were chiefly meteoric waters and had delta-18-O and delta-D values that had been modified by evaporation. Stable isotope studies suggested a common source of recharge in the two basins. Dissolution of pre-existing evaporite salts and weathering of Neogene volcanic rocks were the probable sources for most of the dissolved constituents in Punta Negra Basin ground and surface waters. Dissolved constituents in the Hamburgo Basin waters, particularly the relatively high concentration of SO4, were derived from weathering of a nearby porphyry copper deposit. Mine waters from within the porphyry copper deposit showed a positive shift in delta-18-O relative to other Hamburgo Basin waters, with only a minor increase in delta-D. These higher delta-18-O values may represent a mixing line between meteoric and deep-seated metamorphic waters. The speculation that some components of the mine waters were derived from substantial depths was supported by the unusually high Cl content of the mine waters and by the CO2-rich gas which evolved from these waters. An alternative interpretation is that the relatively high delta-18-O values may represent the evaporative concentration of meteoric waters recharged under wetter and cooler climatic conditions, perhaps during the late Pleistocene. (Korn-PTT)
W91-07834

GROUNDWATER RECHARGE THROUGH THE UNSATURATED ZONE OF SOUTHEASTERN BOTSWANA: A STUDY OF CHLORIDES AND ENVIRONMENTAL ISOTOPES.
Botswana Univ., Gaborone. Dept. of Geology.
For primary bibliographic entry see Field 2G.
W91-07925

ENVIRONMENTAL TRACER APPROACH AS A TOOL FOR HYDROLOGICAL EVALUATION AND REGIONALIZATION OF CATCHMENT SYSTEMS.
Technische Univ. Braunschweig (Germany, F.R.). Inst. fuer Geographie.
For primary bibliographic entry see Field 2E.
W91-07926

LARGER-SCALE HYDROLOGICAL MODELLING FOR REGIONAL TRANSFERRING OF HYDROLOGICAL INFORMATION.
Institut fuer Wasserwirtschaft, Berlin (German D.R.).
For primary bibliographic entry see Field 2E.
W91-07927

SIMPLE CHLORIDE BALANCE ROUTING METHOD TO REGIONALIZE GROUNDWATER RECHARGE: A CASE STUDY IN SEMI-ARID BOTSWANA.
Vrije Univ., Amsterdam (Netherlands). Inst. voor Aardwetenschappen.
J. J. De Vries, and A. Gieske.
IN: Regionalization in Hydrology. IAHS Publication No. 191. International Association of Hydrological Sciences, Washington, DC. 1990. p 81-89, 4 fig, 7 ref.

Descriptors: *Botswana, *Chlorides, *Groundwater basins, *Groundwater recharge, *Regional analysis, *Semiarid lands, *Tracers, Environmental tracers, Hydrologic models, Mathematical equations, Mathematical models, Recharge basins, Soil water, Solute transport.

Research is going on in semiarid Botswana to assess the recharge in a series of small groundwater basins, developed along a fracture system in Precambrian rocks. Multiple recharge sources occur with their individual response to the alternating wet and dry periods of varying time scale. The characterization of groundwater, surface water and soil moisture through their chloride concentration appears to be an excellent tool to quantify the various recharge components. The groundwater is routed through the basin by subdividing the watershed into a number of cells in which complete mixing of chloride is assumed, and for which a mass balance of water and chloride is established. The mathematical problem posed by the four cell system is equivalent to a system of eight equations with eight unknown variables, and therefore in general, only one solution exists. When not only chlorides but also other chemical and isotopic tracers are considered, the number of equations becomes larger than the number of variables. In this case the flow problem can be solved by quadratic programming or by general linear regression techniques. A detailed hydrochemical study is currently being undertaken to determine the extent to which other tracers beside the chlorides can be useful in the environment of southeastern Botswana. (See also W91-07920) (Author's abstract)
W91-07929

REGIONALIZATION IN KARST REGIONS.
Split Univ. (Yugoslavia). Faculty of Civil Engineering Sciences.
O. Bonacci.
IN: Regionalization in Hydrology. IAHS Publication No. 191. International Association of Hydrological Sciences, Washington, DC. 1990. p 135-145, 5 fig, 14 ref.

Descriptors: *Groundwater movement, *Karst, *Karst hydrology, *Regional analysis, *Surface-groundwater relations, Carbonate rocks, Flow characteristics, Parameter estimation, Research priorities, Solutes, Water level.

Hydrologic regional analysis in karst is much more complex and less reliable than in non-karst terrains. Qualitative, reliable regional analysis is negatively affected by direct interaction between surface water and groundwater. The most reliable results have been obtained for low water levels because of the relatively simple flow characteristics, whereas for medium, and particularly for high, water levels regionalization has not helped. The specific features of flow through soluble rocks in karst directly affect the approach to parameter selection. It is necessary to define two major solution mechanisms--differential and homogeneous solution. The occurrence of two completely different flow types--diffuse and conduit flow--should also be kept in mind. Further research should probably be directed towards the definition of particular hydrological and regional parameters for both these flow types. (See also W91-07920) (Fish-PTT)
W91-07934

PROCEEDINGS OF 10TH SALT-WATER INTRUSION MEETING.
Proceedings of a symposium held May 16-20, 1988, Ghent, Belgium. Geologisch Instituut R.U.G. (S 8), Ghent. 1989. 405p. Edited by W. DeBreuck and L. Walschot.

Descriptors: *Belgium, *Coastal aquifers, *Conferences, *Model studies, *Saline groundwater, *Saline water intrusion, *Saline-freshwater interfaces, *Symposium, *The Netherlands.

The Salt-Water Intrusion Meetings are informal gatherings to facilitate contacts between scientists of different background. The most recent meeting was hosted by the University of Ghent, Belgium, whose team from the Laboratory of Applied Geology and Hydrogeology were significant contributors to the symposium. Although Belgium's coastal region and its towns have an ample supply of drinking water from inland resources, the small fresh-groundwater reserves are locally very important. The water management of the polders cannot ignore the relationship between fresh and salt groundwater. This symposium was organized into the categories of: general surveys, regional studies, mathematical calculations and modeling, methods and instruments, hydrochemical and soil-physical investigations, geophysical investigations, and excursions. (See W91-07948 thru W91-07981) (Fish-PTT)
W91-07947

HYDROCHEMICAL EVIDENCE OF FRESH AND SALT-WATER INTRUSIONS IN THE COASTAL DUNES AQUIFER SYSTEM OF THE WESTERN NETHERLANDS.
Keuringsinstituut voor Waterleidingartikelen, Rijswijk (Netherlands).
P. J. Stuyfzand.
IN: Proceedings of 10th Salt-Water Intrusion Meeting. Geologisch Instituut R.U.G. (S 8), Ghent. 1989. p 9-29, 14 fig, 5 tab, 53 ref.

Descriptors: *Coastal aquifers, *Groundwater chemistry, *Saline water intrusion, *Saline-freshwater interfaces, *The Netherlands, Aquicludes, Aquitards, Chlorides, Dunes, Freshwater, Groundwater dating, North Sea, Paleohydrology, Reclaimed water, Saline groundwater, Upconing.

Hydrochemistry is a powerful tool in the study of the hydrology and hydrological evolution of coastal aquifer systems. The spatial distribution of water types and datings of fresh groundwater have been used, together with geological and hydrological data, to elucidate the hydrological evolution of the coastal area of the Western Netherlands. Freshening, salinizing, and equilibrium water types are discerned in a longitudinal section of 100 km and in two cross sections. Freshening water types are found within the freshwater lens mainly at three locations: (1) the central base reflecting its downward growth in the period 1000-1600 A.D., upon the formation of the young dunes; (2) its inland side, mainly due to its continuing extension in that direction, following the reclamation of brackish lakes behind the dunes in the period 1550-1900 A.D.; and (3) elsewhere within and downstream of thick aquitards with high flow resistance, in which chloride inversions may still be present. Salinizing water types occur mainly on the coastal face of the freshwater lens due to lateral North Sea intrusion and below its central base due to upconing. Under the reclaimed lakes, east of the freshening water types, salinizing water occurs, probably in connection with the Holocene transgression and intrusion and upconing due to intensive drainage as well as volumetric compensation for the expansion of the freshwater lens. The extension of artificially recharged Rhine and polder waters must be considered as a salinization as well. Fresh groundwaters have been dated using 3-H, 14-C, 18-O, and the breakthrough of recharged Rhine water. In the upper aquifer and aquitard (above 20 m-MSL) ages vary from 0-70 years, in the second aquifer (20-70 m-MSL) from 25-400 years. Below an aquiclude at 100 m-MSL, 800 years old dune water was found. (See also W91-07947) (Author's abstract)
W91-07948

HYDROGEOLOGICAL SITUATION AND GROUNDWATER MONITORING IN THE AREA OF THE 'DOLLART PORT PROJECT' IN LOWER SAXONY, FEDERAL REPUBLIC OF GERMANY.
Niedersaechsisches Landesamt fuer Bodenforschung, Hanover (Germany, F.R.)
D. Munstermann, and V. Josopait.
IN: Proceedings of 10th Salt-Water Intrusion Meeting. Geologisch Instituut R.U.G. (S 8), Ghent. 1989. p 65-74, 10 fig, 7 ref.

Descriptors: *Aquifer characteristics, *Drawdown, *Germany, *Groundwater management, *Groundwater movement, *Hydrogeology, Barometric efficiency, Coastal aquifers, Construction methods, Monitoring, Pumping tests, Transmissivity, Water table fluctuations.

A port expansion has been planned in Emden, Germany, for more than twenty years. Groundwater drawdown will be necessary during the construction of the projected harbor expansion. This will have consequences for the groundwater table and the hydrogeological situation in the surrounding area. A large amount of groundwater data has been made available for working out a plan for monitoring during and after construction of the harbor and to provide documentation about the natural, uninfluenced groundwater table without drawdown. The study area is north of the river Ems and consists of coastal marshes and polders. The aquifer consists of Quaternary and Pliocene sand and gravel, covered by low-permeability Holocene sediments. The groundwater table and groundwater movement in the confined aquifer are influenced by the tidal range of the Ems, by the inland groundwater situation outside the tidal influence, the climatic conditions, atmospheric pressure, etc. Manually and automatically monitored groundwater observation wells, weather stations, and chemical groundwater analysis currently yield information on hydraulic and hydrochemical correlation and tidal effects. To document the changes in the hydraulic situation resulting from the construction of the port, it is necessary to monitor the present groundwater conditions for several years. Results of a pumping test along with hydraulic calculations have shown that aquifer transmissivity ranges from 39 to 317 sq m/h, the mean barometric efficiency is 16%, the storage coefficient is 0.00088, and the radius of influence will be 1200 m with a drawdown cone of 7.5 m. The groundwater monitoring plan will provide more information about how large the drawdown will be in the hinterland and how large an area will be influenced. (See also W91-07947) (Fish-PTT)
W91-07952

PARTRAC: DEVELOPMENT AND APPLICATION OF A GROUNDWATER-QUALITY MODEL FOR VARIABLE DENSITY FLOW.
GRONTMIJ N.V., De Bilt (Netherlands).
For primary bibliographic entry see Field 5B.
W91-07956

MODELLING THE SALT-WATER INTRUSION IN THE DUNE WATER-CATCHMENT AREA OF THE AMSTERDAM WATERWORKS.
Amsterdam Waterworks (Netherlands).
J. W. Kooiman.
IN: Proceedings of 10th Salt-Water Intrusion Meeting. Geologisch Instituut R.U.G. (S 8), Ghent. 1989. p 132-142, 10 fig, 2 tab, 6 ref.

Descriptors: *Computer models, *Groundwater movement, *Model studies, *North Sea, *Saline water intrusion, Chlorides, Coastal aquifers, Dunes, Freshwater, Infiltration, Natural recharge, Polders, Selective withdrawal, The Netherlands.

For a number of centuries the natural groundwater recharge has created a freshwater lens under the dunes along the North Sea. Since 1850 two permanent human interferences have had influence on the freshwater lens: (1) the groundwater abstraction for drinking water supply; and (2) the reclamation of the Haarlem Lake behind the dunes. The salt and brackish water intrusion has been known since 1904, when the deep abstraction of fresh water began. With these observations the intrusion can be modeled with a computer program. A first step is to make a representative cross section perpendicular to the coast. The influences of groundwater abstraction and reclamation on the salt water intrusion can be calculated, as well as the length of the freshwater tongue underneath the North Sea and the consequences of deep-well infiltration in the dune-water catchment area. Application of this model shows that the changes in chloride distribution in the layers of the dune-water catchment area are mainly due to the groundwater abstraction, and only for a small part to the reclamation of the Haarlem Lake. The changes in chloride distribution below the Polders Rijnland are mainly due to the reclamation of the Haarlem Lake, and only for a small part to the groundwater abstraction. Deep-well infiltration in the dune-water catchment area has little or no influence on the chloride distribution below Polders Rijnland and the Haarlem Lake Polder. Because of the rough schematic outline used, the influence of deep-well infiltration on the chloride distribution below the dune-water catchment area cannot be calculated. (See also W91-07947) (Fish-PTT)
W91-07958

SOLVING VARYING DENSITY GROUNDWATER PROBLEMS WITH A SINGLE DENSITY COMPUTER PROGRAM.
Keuringsinstituut voor Waterleidingartikelen, Rijswijk (Netherlands).
C. Maas, and M. J. Emke.
IN: Proceedings of 10th Salt-Water Intrusion Meeting. Geologisch Instituut R.U.G. (S 8), Ghent. 1989. p 143-154, 7 fig, 5 ref, append.

Descriptors: *Computer models, *Density stratification, *Groundwater movement, *Model studies, *Saline-freshwater interfaces, Saline water intrusion, Salinity currents, Soil density, The Netherlands.

Although the principles of density-effected groundwater flow at this time well understood, adequately documented computer codes are still not widely available. Fortunately, single density computer programs are adequate for solving rather general regional varying density problems. It was shown that both gradually varying densities and sharp interfaces can be handled, provided that displacement of fluids is negligible during the period of observation (not implying steady flow). Density can then be regarded as a soil property. The essential feature of the method is a suitable transformation of input variables and boundary conditions, which can be performed by a simple preprocessing program. The technique was illustrated by two elementary interface problems with known analytical solutions. Subsequently, the method was successfully applied to the catchment area of the Amsterdam Waterworks (The Netherlands). All calculations were performed with the original version of the USGS groundwater program MODFLOW, without any adaption of the source code. (See also W91-07947) (Author's abstract)
W91-07959

PREDICTION OF THE CHLORIDE CONTENT IN THE ABSTRACTED WATER OF THE 'DE GROEVE' WELL FIELD.
Keuringsinstituut voor Waterleidingartikelen, Rijswijk (Netherlands).
J. H. Peters.
IN: Proceedings of 10th Salt-Water Intrusion Meeting. Geologisch Instituut R.U.G. (S 8), Ghent. 1989. p 155-164, 8 fig, 12 ref.

Descriptors: *Chlorides, *Groundwater resources, *Model studies, *Saline water intrusion, *Solute transport, *The Netherlands, *Well fields, Brackish water, Groundwater movement, Selective withdrawal.

At the well field 'De Groeve,' located in the northern part of the Netherlands, over 8 million cu m of groundwater is abstracted annually. Just northeast of the well field approximately 30 million cu m of brackish water with a chloride content up to 900 mg/L is present within the exploited aquifer. The phenomenon is supposed to be of Eemian origin, due to transgression of the sea in that period. Geo-electric soundings have shown the lens to be of finite extent. Shape, size, and location are affected by groundwater flow and thus by the abstraction. With the help of a groundwater solute transport model, chloride content in the mixed raw water in the next century may be predicted, as well as answering questions regarding the operational scheme of the well field. It was shown that remedial action to prevent the chloride content from exceeding an arbitrary 100 mg/L standard is not

likely to be necessary. (See also W91-07947) (Author's abstract)
W91-07960

COMPARISON OF DIFFERENT METHODS FOR REPRESENTING THE HYDRODYNAMIC TENSOR IN NUMERICAL MODELS.
Hydraulics Research Ltd., Wallingford (England).
C. E. Reeve.
IN: Proceedings of 10th Salt-Water Intrusion Meeting. Geologisch Instituut R.U.G. (S 8), Ghent. 1989. p 165-173, 6 fig, 1 tab, 12 ref.

Descriptors: *Coastal aquifers, *Dispersion, *Groundwater movement, *Model studies, *Numerical models, *Saline water intrusion, Aquifer characteristics, Dispersion coefficient, Hydrodynamics, Numerical analysis, Saline-freshwater interfaces, Selective withdrawal, Vertical flow, Well pumping.

In coastal aquifers where the width of the transition zone between the heavier salt water and the overlying lighter freshwater is large relative to the thickness of the aquifer, the effect of dispersion needs to be considered. Numerical models of these aquifers simulate this effect through a term representing hydrodynamic dispersion. Over the last 30 years, a number of methods for representing this term have been reported. A numerical model was used to compare three of these methods both in the presence and absence of well abstraction. A steady-state model was utilized which takes into account the density variations due to the salt. The model was used to simulate flow in a two-dimensional vertical section of aquifer perpendicular to the coast. Spatial discretization was carried out using the Galerkin Finite Element method with linear basis functions and isoparametric quadrilaterals. The abstraction well was represented as a line source which extends throughout the depth of the confined, homogeneous, isotropic aquifer which was simulated. The hydrodynamic dispersion tensor was represented as being constant, linearly dependent on the flow velocity perpendicular to the coast and by the method described by Bear. It was found that for all three representations the effect of increasing the dispersion coefficient is similar in both the non-abstraction and abstraction cases: the isochlors become steeper as the dispersion coefficient increases. The result is in agreement with that expected from mixing theory. No general pattern, that is applicable to the complete range of dispersion coefficient values investigated, arises from comparison of the three methods of representation. (See also W91-07947) (Author's abstract)
W91-07961

MODELLING OF A COASTAL AQUIFER IN MEXICO: THE SIMULATION OF THE SALT-WATER INTERFACE MOTION.
Ecole Nationale Superieure des Mines de Paris, Fontainebleau (France). Centre d'Information Geologique.
A. Rivera, and E. Ledoux.
IN: Proceedings of 10th Salt-Water Intrusion Meeting. Geologisch Instituut R.U.G. (S 8), Ghent. 1989. p 174-190, 21 fig, 3 tab, 9 ref.

Descriptors: *Coastal aquifers, *Mexico, *Model studies, *Saline water intrusion, *Saline-freshwater interfaces, Aquifer characteristics, Diffusivity, Fluid flow, Freshwater, Groundwater movement, Numerical analysis, Pump wells, Saline water, Steady flow, Unsteady flow, Upconing.

One of the principal difficulties found in modeling coastal aquifers involves the efficient and accurate simulation of the movement of the saltwater-freshwater front. A numerical model was applied to a coastal aquifer in Mexico to simulate single-phase and two-phase fluid flow. The single-phase part of the model solves the diffusivity equation and helps to identify certain parameters of the aquifer and to simulate the flow field (freshwater) under different conditions. The two-phase part of the model solves the partial differential equations describing the motion of salt water and freshwater separated by a sharp interface. The model was calibrated using the observed piezometry of the aquifer for the freshwater flow field. Simulations were made both in steady and unsteady-state conditions, to establish the position and movement of the interface toe under different types of pumping. Results show that the model reproduces very accurately the flow field of freshwater. It identifies the potential saltwater intrusion (upconing) into some of the pumping wells, thus helping in the identification of optimal pumping schemes. (See also W91-07947) (Author's abstract)
W91-07962

EXPERIMENTS ON THE MOVEMENT OF BRACKISH WATER NEAR INFILTRATION AND ABSTRACTION WELLS.
Waterworks of North-Holland, Bloemendaal (Netherlands).
A. Stakelbeek.
IN: Proceedings of 10th Salt-Water Intrusion Meeting. Geologisch Instituut R.U.G. (S 8), Ghent. 1989. p 191-199, 10 fig, 8 ref.

Descriptors: *Brackish water, *Deep wells, *Groundwater movement, *Model studies, *Saline water intrusion, *The Netherlands, *Upconing, Computer models, Freshwater, Infiltration, Injection wells, Saline-freshwater interfaces, Selective withdrawal, Vertical flow.

The Provincial Waterworks of North Holland (PWN) are starting the construction of a 5 million cu m/a deep-well plant in the North Holland dune area near the North Sea. In this plant, injection of filtrated IJssel-lake water and abstraction will take place at a depth of respectively 10 and 25 m above the brackish zone, which is located about 100 m below mean sea level. Due to the fact that the injection will exceed the abstraction, intrusion and upconing of brackish water will be prevented. In case of calamities, when the infiltration may be interrupted, it is important to know how long the abstraction can be continued, before upconing of brackish water will occur. Therefore, from 1983-1987 the Provincial Waterworks investigated the movement of the brackish zone by abstracting and infiltrating water in a deep well, in which the filter was located only 10 m above the brackish zone. During the experiments the movement of the brackish zone was intensively measured by vertical multi-electrode cables. During the abstraction the brackish zone reached the well-filter within two months. After a break of a few years, during which the measurements were continued, the brackish zone was pushed downwards by infiltrating freshwater. Due to the growing distance between the well filter and the brackish zone during the infiltration, the vertical velocity of the brackish zone decreased in time. In order to extrapolate from the conclusions of the infiltration and abstraction experiment to the future deep-well plant, the experiments on the movement of the brackish zone were simulated by computer modeling. For the simulations two different computer codes (AQ-AS and SALTP3) were tested and compared, showing that the AQ-AS program is probably overestimated and the SALTP3 program gives a more realistic calculation of the upconing. (See also W91-07947) (Author's abstract)
W91-07963

DEVELOPMENT OF A KNOWLEDGE SYSTEM FOR MODELLING FRESH AND SALINE-GROUNDWATER FLOW.
Technische Hogeschool Delft (Netherlands). Dept. of Civil Engineering.
B. B. W. Thorborg, and G. Jousma.
IN: Proceedings of 10th Salt-Water Intrusion Meeting. Geologisch Instituut R.U.G. (S 8), Ghent. 1989. p 200-209, 5 fig, 12 ref.

Descriptors: *Groundwater management, *Groundwater movement, *Hydrologic models, *Model studies, *Saline groundwater, *Saline water intrusion, *The Netherlands, Computer models, Model testing, Saline-freshwater interfaces.

Increasing demands on freshwater resources during recent years on the one hand and the widespread availability of computer technology on the other have encouraged the development and application of modeling software for the simulation of groundwater system behavior. A system for modeling fresh/saline flow has been developed that is designed to provide: (1) a structure and the information for the analysis of problem data and the selection of solution methods or models in relation to the availability of data; and (2) information on verification of model codes and their performance during tests and applications, to the extent that this information is relevant to a specific problem. The development of a model consists of five stages: (1) problem formulation and data analysis; (2) conceptualization; (3) selection of solution methods; (4) selection of model codes; and (5) simulation. In order to illustrate the suggested approach, an examination was made of the validity of some commonly-applied assumptions and simplifications for certain freshwater/saltwater problem types, by means of comparing test results. It was found that it is essential that all the general information required to make choices be readily available, and the available problem-specific information must be used at early stages of the analysis to control the process. Thus criteria can be derived for the application of models based on these assumptions. The knowledge required to build such a system can be derived from theoretical considerations, from comparative studies using benchmark problems and from evaluation of test results, field studies and model applications. (See also W91-07947) (Fish-PTT)
W91-07964

PARTIALLY PENETRATING WELLS IN A DUPUIT TYPE FRESH/SALT FINITE-ELEMENT MODEL.
Keuringsinstituut voor Waterleidingartikelen, Rijswijk (Netherlands).
J. P. van der Eem.
IN: Proceedings of 10th Salt-Water Intrusion Meeting. Geologisch Instituut R.U.G. (S 8), Ghent. 1989. p 210-219, 12 fig, 4 ref.

Descriptors: *Aquifers, *Finite element method, *Model studies, *Saline water intrusion, *Saline-freshwater interfaces, *Well hydraulics, Deep wells, Dupuit-Forchheimer theory, Injection wells, Selective withdrawal, Upconing, Vertical flow.

For calculation of the regional position of the (sharp) interface between fresh and saline water, finite-element models with a Dupuit-Forchheimer assumption can be used. The resistance to vertical flow in an aquifer is assumed zero in such models. When, however, a partially penetrating well is abstracting (or infiltrating) water in the freshwater zone directly on top of the saltwater layer, then the assumption can lead to a largely overestimated upconing (or depressing) of the interface. In order to get a more realistic impression of the position of the interface around the well, it is possible to compute the local vertical resistance analytically, and to take the results into account in the finite-element computations. The adapted finite-element model was tested using semi-analytical, two-dimensional solutions obtained with the vortex method. The adaption reduced the movement of the interface and showed results that agreed well with the vortex solution. A semi-three-dimensional computation was made for the position of the interface at a deep-well infiltration system with one line of infiltration wells centered between lines of abstraction wells. However, the finite-element model adapted in such a way shows a tendency to underestimate the displacement of the interface between fresh and salt water. This is explained by the fact that the influence of an inclined interface on the flow field is dealt with according to the Dupuit-Forchheimer approach, although the influence is 3-dimensional. (See also W91-07947) (Fish-PTT)
W91-07965

APPLICATION OF THE FACTOR-ANALYSIS METHOD TO STUDY THE ORIGIN AND EVOLUTION OF THE SALINIZATION IN THE AQUIFER SYSTEM NO. 25 (HUELVA PROVINCE, SPAIN).
Escuela Univ. Politecnica de la Rabida, Huelva (Spain). Dept. de Geologia.
A. G. Martinez, I. A. Auzmendi, V. S. Villasante,

and R. B. Lucena.
IN: Proceedings of 10th Salt-Water Intrusion Meeting. Geologisch Instituut R.U.G. (S 8), Ghent. 1989. p 220-228, 4 fig, 4 tab, 5 ref.

Descriptors: *Factor analysis, *Groundwater chemistry, *Model studies, *Spain, Mineralization, Saline groundwater, Saline water, Saline water intrusion.

The Principal Components Analysis (PCA) is a very useful factor-analysis method for any hydrochemical study. This method was applied to chemical analysis of water samples of the Aquifer System No. 25 in the Huelva Province, Spain, and the results were analyzed in order to study the origin of the saline content of these waters and its temporal and spatial evolution. An obvious temporal progressive increase of mineralization (particularly Cl and Na) was observed in the wells located in the central-western area of the littoral belt. This fact is interpreted as a marine intrusion although still not very well developed. Most of the waters from the system present low and very similar mineralization among them. During the studied period (1979-1986), a tendency towards a progressive increase in any of the components, was not detected. Locally, problems of congenital salinity are responsible for the high salinity and mineralization in certain waters, in which the dilution-concentration phenomena related to the wet-dry periods, are very obvious. The use of the PCA factor-analysis method was concluded to be a very useful method for studying the origin and spatial/temporal evolution of the water salinity in the aquifer system. (See also W91-07947) (Fish-PTT)
W91-07966

SALT-WATER INTRUSION CONTROL WITH ELECTRIC BARRIERS.
Cagliari Univ. (Italy). Cattedra di Geologia Applicata.
G. Barbieri, G. Barrocu, and G. Ranieri.
IN: Proceedings of 10th Salt-Water Intrusion Meeting. Geologisch Instituut R.U.G. (S 8), Ghent. 1989. p 231-237, 6 fig, 1 ref.

Descriptors: *Electrical equipment, *Groundwater barriers, *Groundwater management, *Saline water intrusion, Electrodes, Groundwater movement, Laboratory methods, Sand aquifers.

A physical laboratory model has been made to test the feasibility of employing electrical methods to counteract seawater encroachment. The possibility of using a system of electrodes placed in the soil to create an electric barrier against saltwater intrusion has been verified by simulating filtration flow in a phreatic sandy aquifer. A number of tests were carried out with direct and alternating currents of different frequencies. The efficiency of the system was assessed by comparing the variation in time of salinity due to progressive saltwater encroachment with salinity variation recorded during a standard test carried out without energizing the soil. The laboratory tests, carried out on a porous medium model, demonstrated that electrical apparatus may create a barrier against saltwater intrusion in sandy aquifers. The method proved efficient with both direct and alternating currents, though the electrodes are corroded by direct currents. The system is directly dependent on current intensity and frequency. Alternating current effects seem to be caused by ionic excitement movement, the ions concentrating near the electric barrier and rarefying downstream. Saltwater encroachment is mainly counteracted in a short time so that downstream from the electrodes salinity decreases by more than 65%. Electric barrier efficiency gradually decreases where ions may combine and NaCl precipitates in high concentrations. The model limits that might have affected the results were preferential saltwater flow either at the contact between sand and tank walls or at the sides and below the barrier. The efficiency of the method must yet be tested in the field. (See also W91-07947) (Fish-PTT)
W91-07967

HYDRAULIC MANAGEMENT APPROACH FOR SALT-WATER INTRUSION USING TWO-LEVEL PUMPING MECHANISM.
Soil and Water Research Inst., Giza (Egypt).
M. S. M. Farid.
IN: Proceedings of 10th Salt-Water Intrusion Meeting. Geologisch Instituut R.U.G. (S 8), Ghent. 1989. p 238-244, 3 fig, 14 ref.

Descriptors: *Egypt, *Groundwater management, *Groundwater movement, *Pump wells, *Saline water intrusion, *Saline-freshwater interfaces, Coastal aquifers, Discharge measurement, Drawdown, Pumpage, Pumping rates, Viscosity.

Seawater intrusion is the main constraint limiting the full exploitation of the Nile Delta aquifer in Egypt. In some demand areas, groundwater may be the only feasible water resource, but fear of more intrusion or upconing prevents the pumping of the aquifer. An approach has been developed to tackle this problem. The method is based on pumping fresh and saltwater simultaneously from the pumping well. The pumpage is determined by the amount necessary to keep the saline-freshwater interface stationary. The relationship between the amounts of freshwater discharge and saltwater discharge was formulated; the discharge of saltwater is approximately 0.75 times the discharge of freshwater in the ideal case. Insufficient knowledge of dynamic viscosity is the main limiting factor of the suggested approach. The ratio between salt/freshwater drawdowns is simply equal to 0.975, the inverse of the ratio between the densities of the two fluids in the ideal case. This approach can be applied in the case of development of coastal aquifers, and is very useful to maximize the utilization of the Nile Delta aquifer to achieve the future water requirements especially in the outer fringes of the Delta where the seawater intrusion problem is very critical. (See also W91-07947) (Fish-PTT)
W91-07968

FRESH AND SALT-WATER INTRUSION: LABORATORY EXPERIMENTS AND GEOCHEMICAL TRANSPORT MODELLING.
Vrije Univ., Amsterdam (Netherlands). Inst. voor Aardwetenschappen.
H. E. Beekman, and C. A. J. Appelo.
IN: Proceedings of 10th Salt-Water Intrusion Meeting. Geologisch Instituut R.U.G. (S 8), Ghent. 1989. p 247-255, 4 fig, 2 tab, 18 ref.

Descriptors: *Cation exchange, *Groundwater chemistry, *Model studies, *Saline water intrusion, *Solute transport, Calcium, Dispersivity, Geochemistry, Ion exchange, Magnesium, Seawater, Selectivity, Soil columns, The Netherlands.

Buffer reactions between sediment and groundwater occur if amounts of exchangeable cations are relatively high compared to concentrations in water. Characteristic concentrations of elements develop in both time and space during dispersive intrusion of fresh and salt water as a result of cation exchange, and may be used to derive paleohydrological information (e.g. location of historical fresh and saltwater interfaces). Experimental data on fresh and saltwater intrusions are rarely available, a limiting factor for multicomponent transport modeling. Column experiments were performed at varying concentration levels in order to obtain such information. Fresh and saltwater intrusions were repeatedly simulated, with good reproducibility, by percolating a sediment-filled column with both seawater (once diluted) and fresh groundwater. The material used comprised a fine-grained unconsolidated sand from Holocene perimarine gully-deposits in the western part of The Netherlands. Calculated dispersivity values were found to be three times larger during the freshwater intrusion in seawater-equilibrated sediment than for the reverse situation. Additional experiments with synthetic solutions indicated a chemical explanation for these differences. Using calculated selectivity coefficients and dispersivity values as input, a geochemical transport model was applied to simulate the multicomponent ion exchange during fresh and seawater intrusions. The results show that seawater intrusion in freshwater equilibrated sediment can only be modeled when the selectivity of calcium over magnesium decreases by a factor of two during the breakthrough. In the case of freshwater intrusion in seawater-equilibrated sediment, the appropriateness of fit is less sensitive to selectivity changes during breakthrough and calibration is thus easier to perform. (See also W91-07947) (Author's abstract)
W91-07969

ISOTOPE STUDIES OF THE HYDROLOGY OF THE GORLEBEN AREA, FRG.
Bundesanstalt fuer Geowissenschaften und Rohstoffe, Hanover (Germany, F.R.).
J. Boehme, and R. Ludwig.
IN: Proceedings of 10th Salt-Water Intrusion Meeting. Geologisch Instituut R.U.G. (S 8), Ghent. 1989. p 256-262, 3 fig, 2 tab.

Descriptors: *Aquifer characteristics, *Geohydrology, *Germany, *Groundwater quality, *Isotope studies, *Observation wells, *Radioactive waste disposal, Carbon radioisotopes, Hydrogen isotopes, Hydrologic data, Oxygen isotopes, Permeability, Pumping tests.

A hydrogeological investigation program is being conducted at the Gorleben site in Germany as part of the studies of the Gorleben salt dome to determine its suitability for a final repository for radioactive waste. The objective of the program is to obtain extensive data on the groundwater quality in the area of the planned repository in order to provide a basis for monitoring after the repository begins operation. Within the scope of this study, samples are routinely collected from the extensive grid of observation wells in the area and analyzed for various hydrochemical and physical parameters and isotope concentrations in the groundwater. Hydrogeological cross-sections and maps have been made of the isotope data, primarily 3-H, 14-C, and 18-O. The isotope data were interpreted taking into consideration the hydrogeological conditions and other data, e.g. from pumping tests. Four main hydrogeological units were defined, based on exploration drilling and pumping tests, coinciding generally with the vertical distribution of the 14-C concentration in groundwater. In contrast to the low-permeable units the better-permeable units show the higher 14-C concentrations (>10 pmc) with a decrease in the 14-C level from the upper freshwater aquifer system (15-50 pmc) to the lower aquifer system (10-20 pmc). In the low-permeable units (clayey complex and upper saline water aquifer system) a 14-C concentration level <8 pmc has been observed. Two main effects are probably responsible for the decrease of the 14-C concentrations: (1) radioactive decay; and (2) dilution by solution of paleocarbonate (partially supported by bacteriological CO2 production). The calculated 14-C model ages are rather uncertain as the dilution effect cannot yet be taken into account with adequate accuracy. (See also W91-07947) (Fish-PTT)
W91-07970

PROCESSES IN THE MIXING ZONE IN CARBONATE FORMATIONS: CENTRAL AND SOUTHERN CATALONIA.
Universidad Politecnica de Cataluna, Barcelona (Spain). Escuela Tecnica Superior de Ingenieros de Caminos, Canales y Puertos.
E. Custodio, M. Pascual, A. Bayo, and X. Bosch.
IN: Proceedings of 10th Salt-Water Intrusion Meeting. Geologisch Instituut R.U.G. (S 8), Ghent. 1989. p 263-277, 7 fig, 2 tab, 13 ref.

Descriptors: *Aquifer characteristics, *Carbonates, *Coastal aquifers, *Geohydrology, *Saline groundwater, *Saline water intrusion, *Spain, Boreholes, Mixing, Permeability, Salinity, Vertical flow.

Hydraulic conductivity heterogeneities in coastal carbonate formations affect the form and behavior of the mixing zone as observed along fully screened boreholes. The downward increase in salinity shows conspicuous changes in vertical salinity gradients that are found at the same depth over repeated logs. Salinity logs from some studies carried out in two areas in Catalonia, Spain, were examined. One of them is in the southern portion of the Garraf Massif and the other in the Vandellos Massif, this last involving two subareas, one in dolomites and the other in a small, thick alluvial

fan deposit. The changes in vertical salinity gradients reflect changes of permeability inside the mixing zone. They are produced by the borehole itself. Low vertical salinity gradients are associated with low-permeability stretches, but exceptions can be found. Some permeable zones may not appear if they have a head slightly higher than zones below and above, but this situation may change when hydrodynamic conditions vary, and then their position may show up. When taking water samples, high vertical salinity stretches are preferable since water is being renovated corresponding to the sampling depth, but reproductivity is low due to the great influence of small errors in depth. Sampling inside low vertical gradients sections is easier and more reproductive but there are more chances for water being altered by interactions with the casing, and the depth from which it comes is not well known. (See also W91-07947) (Author's abstract)
W91-07971

TOOLS FOR INVESTIGATING THE ORIGIN OF ANOMALIES IN CHLORIDE CONTENT OF GROUNDWATER IN COASTAL LOWLANDS.
Institute of Applied Geoscience TNO, Delft (Netherlands).
J. C. de Ruiter.
IN: Proceedings of 10th Salt-Water Intrusion Meeting. Geologisch Instituut R.U.G. (S 8), Ghent. 1989. p 278-287, 3 fig, 4 ref.

Descriptors: *Chlorides, *Coastal aquifers, *Groundwater chemistry, *Model studies, *Saline groundwater, *Saline water intrusion, *The Netherlands, Cation exchange, Groundwater dating, Groundwater movement, Isotope studies, Peat bogs, Solute transport.

The best approach for starting an investigation of saline water intrusion is to look for descriptions, maps, and other information in order to get an idea of the succession of different landscapes in the area. In The Netherlands, transgression stages with saltwater influence may have alternated with regression stages with freshening influences from rivers and peat moors. A change of the relative altitude of parts of the landscape may have caused a reversal of the direction of freshening and salinizing processes. A possible second tool is the chemical groundwater classification with emphasis on cation exchange in order to determine the difference between salinizing and freshening processes in combination with chloride content. To screen the hypothetical situations a third tool, the study of isotopes, may be chosen. With isotope measurements, a differentiation of the ages and origins of freshwater can be made. Hand-in-hand with the study of isotopes, other chemical parameters can be used, depending on the hypothetical origin of groundwater. The fifth tool to be used in the remaining hypothetical situations might be two or three-dimensional groundwater flow and transport modeling. For example, to model a former peat moor, some parameters must be determined from other known parameters, e.g. influence depth and influence time. However, no data about the heights of the former peat moors in the western part of The Netherlands are known. By developing different models the plausibility of the hypotheses might be tested, using a number of hypothetical heights as input data for the model code. (See also W91-07947) (Author's abstract)
W91-07972

SOME PROCESSES IN THE SEA-WATER/FRESH-WATER INTERFACE, AS INFLUENCED BY THE PRESENCE OF GASES.
Calgary Univ. (Alberta). Dept. of Geology and Geophysics.
L. C. Goldenberg, and S. Mandel.
IN: Proceedings of 10th Salt-Water Intrusion Meeting. Geologisch Instituut R.U.G. (S 8), Ghent. 1989. p 288-299, 6 fig, 25 ref.

Descriptors: *Coastal aquifers, *Gases, *Groundwater movement, *Saline-freshwater interfaces, *Soil gases, Bubbles, Capillary water, Clay minerals, Clay soils, Groundwater barriers, Injection wells, Interstitial water, Permeability, Porous media, Recharge wells, Saline water intrusion.

Gases may influence processes in zones of freshwater/seawater interface of coastal aquifers. One of the sources of gas bubbles is recharge wells. The bubbles of gas, alone or in combination with clay particles, impair flow. The flow impairment may not allow the use of the recharged water for controlling seawater intrusion. Results of laboratory experiments that simulated circumstances of an operating recharge well indicate the following trends: (1) quasi-stable bubble-mineral particle units form, due to adhesion of hydrophobic colloids (clay minerals) on the surface of air bubbles, which may become mobile when the pressure gradient in the porous medium is larger than a threshold value; (2) introduction of a small volume of air in pure sand induces a steady state of slightly reduced permeability, if either a concentrated solution ('seawater') or a dilute solution ('freshwater') fills the pores; a lower permeability is attained in a sediment where equilibrium exists between the electrical atmosphere of the clay platelets attached on the bubbles and the surrounding solution, and/or if the electrical atmosphere is suppressed by a concentrated solution; and (3) an irreversible decrease of permeability may be induced by the combined effect of bubbles and voluminous three-dimensional structures of smectite, possibly arising when freshwater replaces seawater in the pores of mixtures of sand and traces of smectite. A state where the sediment in the vicinity of a borehole is clogged by bubbles and clay particles reduces the efficiency of a well for serving as a recharge well. Injection of air into the seawater/freshwater interface may be used as a method for reducing seawater encroachment. (See also W91-07947) (Author's abstract)
W91-07973

ESTIMATION OF THE LATERAL DISPERSIVITY IN A HOMOGENEOUS ISOTROPIC COASTAL AQUIFER.
Lund Univ. (Sweden). Dept. of Water Resources Engineering.
K. Jinno, R. Berndtsson, K. Momii, and T. Hosokawa.
IN: Proceedings of 10th Salt-Water Intrusion Meeting. Geologisch Instituut R.U.G. (S 8), Ghent. 1989. p 300-307, 7 fig, 2 tab, 5 ref.

Descriptors: *Coastal aquifers, *Dispersivity, *Groundwater movement, *Model studies, *Numerical models, *Saline water intrusion, Saline-freshwater interfaces, Salinity, Simulation analysis.

A method for estimation of the lateral dispersivity in a homogeneous isotropic coastal aquifer where saltwater intrusion takes place has been developed. A similarity approximation was used for both the tangential velocity along and the transverse saltwater concentration profile to the steady fresh/saltwater interface obtained by immiscible assumption. In order to confirm the validity of the proposed procedures, a two-dimensional numerical simulation procedure was compared with experimental data. It was found that the mass transport in the mixing zone may be obtained by the present numerical simulation method. The 90% concentration isoline of saltwater agrees well with the observed interface of the experiments and also with the equation of fresh/saltwater. An approximate solution obtained by the similarity assumption along the fresh/saltwater interface may well represent the measured concentration profile. The estimated lateral dispersivities agree well with the predicted values by the Harleman and Rumers' formula when an overall Reynolds number is used. The numerical simulation using estimated longitudinal and lateral dispersivities can represent the vertical concentration profile observed in the experiments. It is expected that the proposed method will give a reasonable estimation for the lateral dispersivity when it is applied to a coastal aquifer where saltwater intrusion takes place. (See also W91-07947) (Fish-PTT)
W91-07974

TEMPERATURE OF GROUNDWATERS IN COASTAL AQUIFERS: SOME ASPECTS CONCERNING SALT-WATER INTRUSION.
Bari Univ. (Italy). Ist. di Geologia Applicata e Geotecnia.
L. Tulipano, and M. D. Fidelibus.
IN: Proceedings of 10th Salt-Water Intrusion Meeting. Geologisch Instituut R.U.G. (S 8), Ghent. 1989. p 308-316, 4 fig, 9 ref.

Descriptors: *Aquifer characteristics, *Coastal aquifers, *Groundwater movement, *Italy, *Saline water intrusion, *Temperature gradient, *Water temperature, Geothermal water, Permeability, Saline groundwater.

The temperature of groundwater is mainly a function of its mobility in an aquifer. The more anisotropic the aquifer, the more pronounced the thermal variations developing in it. In a coastal aquifer the presence of seawater at the base of fresh groundwater and mixing processes between these two types of water are the additional factors which influence temperature distribution. In fact the residence times of saltwater are generally much longer than those of freshwater. Therefore, in the absence of significant perturbing processes, the thermal gradients of saltwater bodies are positive and higher than those found in freshwater. The coastal aquifer of the Salento peninsula in Italy occurs in carbonate rocks which owe their permeability to fracturing and karst processes. Because of this the aquifer is strongly anisotropic. The trend of isogeothermal surface has been reconstructed for this aquifer based on the correlation of temperature logs along horizontal and vertical sections. The temperature proved to be an excellent tracer in the recognition of the main hydrogeological pathways and their interconnections, as well as in the identification of factors which strongly influence the evolutionary processes of saltwater contamination of fresh groundwater. (See also W91-07947) (Author's abstract)
W91-07975

CHEMICAL AND ISOTOPICAL METHODOLOGIES IN THE STUDIES ON ORIGIN AND EVOLUTION OF GROUNDWATERS FLOWING IN THE COASTAL CARBONATE AND KARST AQUIFER OF APULIA (SOUTHERN ITALY).
Palermo Univ. (Italy). Ist. di Mineralogia.
R. Alaimo, A. A. Grifeo, M. D. Fidelibus, and L. Tulipano.
IN: Proceedings of 10th Salt-Water Intrusion Meeting. Geologisch Instituut R.U.G. (S 8), Ghent. 1989. p 317-325, 11 fig, 15 ref.

Descriptors: *Aquifer characteristics, *Coastal aquifers, *Groundwater chemistry, *Isotope studies, *Italy, *Saline water intrusion, Groundwater recharge, Karst hydrology, Paleohydrology, Permeability, Springs, Surface-groundwater relations.

The Murgia and Salento regions of Italy constitute two adjacent and important hydrogeological units. Both aquifers are of the coastal type and have formed in carbonate rocks of the Mesozoic age. The hydrogeological distinction between the two units is due to the overall difference in permeability, which is lower in Murgia compared with Salento. A considerable outflow of the Murgian groundwater feeds the Salento region in addition to the local supply due to precipitation. The determination of the hydrogeological setting of Salento is of special importance for a better understanding of the saltwater contamination processes caused by over-exploitation of the aquifer. A study of the isotope contents and groundwater chemistry were used to reconstruct flow patterns from the morphologically and topographically different supply areas. It was found that the springs geographically belonging both to the Murgia system and to the Salento system drain groundwater which is characterized by a medium degree of evolution, which corresponds to appreciable residence times in the aquifer; it is reasonable to assume that all big springs represent the outlet of wide karstic channels, which represent preferential ways of a rapid discharge. The anisotropy of the Murgia aquifer is so marked that often springs very close to each other belong to very different hydrogeological circuits. The most evolved groundwaters found in the Murgia system flow towards Salento; they gradually lose the original characteristics while mixing with the Salento system groundwater. The high

degree of permeability of the Salento aquifer allows a fast flow of groundwater from the feeding areas to the sea; discharge occurs practically along the entire coastal front. The short residence time allows groundwater to maintain characteristics very close to those of feeding rainwater; the only change in chemical features is due to mixing phenomena with intruding seawater. (See also W91-07947) (Fish-PTT)
W91-07976

DETECTION OF FRESH-WATER/SEA-WATER INTERFACE BY THE TIME DOMAIN ELECTROMAGNETIC (TDEM) METHOD IN ISRAEL.
Institute for Petroleum Research and Geophysics, Holon (Israel).
For primary bibliographic entry see Field 5B.
W91-07977

SALT-WATER INTRUSION MONITORING BY RESISTIVITY AND IP-TOMOGRAPHIC METHODS.
Politecnico di Torino (Italy). Dipt. di Georisorse e Territorio.
For primary bibliographic entry see Field 5B.
W91-07978

RESULTS OF AIRBORNE EM GROUNDWATER EXPLORATION IN A DESERT AREA USING THE CENTROID DEPTH ALGORITHM FOR EVALUATION.
Bundesanstalt fuer Geowissenschaften und Rohstoffe, Hanover (Germany, F.R.).
K.-P. Sengpiel.
IN: Proceedings of 10th Salt-Water Intrusion Meeting. Geologisch Instituut R.U.G. (S 8), Ghent. 1989. p 349-356, 7 fig, 6 ref.

Descriptors: *Algorithms, *Arid-zone hydrology, *Geophysical methods, *Groundwater resources, *Magnetic studies, *Pakistan, *Resistivity, Aircraft, Electrical equipment, Exploration, Geophysical surveys.

Secondary magnetic-field data from a three-frequency electromagnetic (EM) helicopter survey have been evaluated using a novel inversion technique called the centroid depth algorithm. It yields the centroid depth of the electric current system (induced by a dipole source) and the 'ambient' resistivity at this depth, both for each transmitted frequency. It is illustrated by several examples how the true vertical resistivity distribution is approximated by the resistivity as a function of centroid depth. For three transmitted frequencies this function is only partially known but it can be closely represented by a spline interpolation function. The complete, although approximate, resistivity information can be represented as vertical sections along flight lines or horizontal sections at certain preselected depths. Using these techniques the three-dimensional resistivity distribution below a nonperennial river in a desert area in Pakistan was successfully shown and compared with Schlumberger resistivity soundings and results from drillings and dug wells. Several other freshwater deposits in saltwater-bearing environments have been delineated using this airborne EM (AEM) method. Experience has shown that the method has two limitations: (1) a highly conductive cover layer reduces the depth of investigation; below the cover layer the calculated resistivities are less reliable; and (2) complex layering such as a sequence of thin layers with high resistivity contrasts, cannot be resolved using the smooth resistivity function. For optimum interpretation of the AEM resistivity results in terms of groundwater parameters, it is therefore essential to accompany the AEM survey by ground direct current resistivity soundings, hydrogeological investigations and drilling. (See also W91-07947) (Fish-PTT)
W91-07979

HYDROGEOLOGICAL SWIM-EXCURSION TO THE WESTERN COASTAL PLAIN OF BELGIUM.
Ghent Rijksuniversiteit (Belgium). Lab. for Applied Geology and Hydrogeology.
L. Lebbe, and K. Walraevens.
IN: Proceedings of 10th Salt-Water Intrusion Meeting. Geologisch Instituut R.U.G. (S 8), Ghent. 1989. p 359-375, 12 fig, 24 ref.

Descriptors: *Belgium, *Coastal aquifers, *Coastal plains, *Field tests, *Groundwater resources, *Saline water intrusion, *Saline-freshwater interfaces, Catchment areas, Dunes, Geophysical methods, Polders, Resistivity, Seawater.

In the larger part of the Flemish coastal plain the possibilities of freshwater exploitation are limited. Three possibilities exist: exploitation of the deep artesian aquifers, exploitation of the shallow phreatic aquifer, and collection of surface water in artificially-created basins. For the management of the fresh groundwater a thorough knowledge of the distribution and the flow of fresh and saltwater is necessary. A Salt-Water Intrusion Meeting (SWIM) excursion was made to the western Belgian coastal plain. The first visiting point was the shore at Groenendijk Bad, where the phenomenon of the saltwater lens above the freshwater tongue was extensively studied on the French-Belgian border using two borings. From the shore, the group drove through the young dunes to the polder area. It was observed that tourism plays an important role in the economy of the West Coast. It was seen that only a small part of the young dunes are, until now, not situated in builtup areas. This small part consists of the two water-catchment areas, planned water-catchment area, and three natural reserves, two of which are regional and one is municipal. The polder area is principally a rural area, with the exception of the small town of Veurne. In the polder area, the pressure and the distribution of salt and freshwater was shown with the help of resistivity logs. The polder area can be subdivided into three characteristic regions: the Old Land (the large protected area), the Middle Land (the higher-ground, less-protected area), and the low-lying polders (a brackish lake before reclamation). In the low-lying polders there is an important upward flow of salt and brackish water near the highest boundary area, the old dunes. Borehole resistivity logs were performed here (converted to an observation well) and showed an increase toward the east in the total salt content of the saltwater under the semi-pervious layer. (See also W91-07947) (Fish-PTT)
W91-07980

HYDROGEOLOGICAL SWIM-EXCURSION TO THE BLACK-SLUICE POLDER AREA IN THE FLEMISH VALLEY OF BELGIUM.
Ghent Rijksuniversiteit (Belgium). Lab. for Applied Geology and Hydrogeology.
K. Walraevens, L. Lebbe, and K. Pede.
IN: Proceedings of 10th Salt-Water Intrusion Meeting. Geologisch Instituut R.U.G. (S 8), Ghent. 1989. p 376-395, 13 fig, 18 ref.

Descriptors: *Belgium, *Coastal aquifers, *Dikes, *Field tests, *Polders, *Saline water intrusion, Conductivity, Drainage canals, Groundwater movement, Saline groundwater, The Netherlands, Upconing.

The Black-Sluice Polder area is a group of 11 smaller polders each bordered by dikes, situated in the north of Belgium near the Dutch border, which forms the northern and eastern boundary limits. The southern border is a dike which separates the polders to the north from the 'woodland' to the south. Brackish and salt groundwater occur at different depths in the polder area; more intense drainage periods causes the freshwater layer to diminish, causing the salt groundwater to rise, eventually reaching the surface. The salinization process makes the soil unfit for agricultural use. Recent research is based on extensive field observations. A Salt-Water Intrusion Meeting (SWIM) excursion was made to the Black-Sluice Polder area to observe and confirm past and recent hydrogeological research. The group visited the village of Assenede (on a high 'ridge' on the edge of the 'woodland', drained by a freshwater brook with conductivity 700 microS/cm); entered the polder area (where the brook gets brackish to salt groundwater from the polder area, with a conductivity increased to 2700 microS/cm); walked down several dikes (observing historic creek erosion); to Posthoorn Dike (a seawall and flood dike); to the village and port of Boekhoute (plagued by siltingup); to a pumping station (which pumps drainage water from a canal to a creek); to a deep boring site (close to an important drainage canal which is expected to cause an upward flow; site of hydraulic head measurements which show some downward flow in the upper levels; and chemical evidence of saltwater upconing); and to the Black Sluice (historically used to drain the polder area, now providing a conduit for inflowing water). (See also W91-07947) (Fish-PTT)
W91-07981

RADON CONCENTRATIONS IN GROUND WATER OF THE GEORGIA PIEDMONT.
Georgia Inst. of Tech., Atlanta. School of Earth and Atmospheric Sciences.
For primary bibliographic entry see Field 5B.
W91-08176

ORGANIC CHEMICAL ANALYSIS OF GROUND WATER IN LOUISIANA: WATER YEARS 1984-88.
Geological Survey, Baton Rouge, LA. Water Resources Div.
For primary bibliographic entry see Field 5A.
W91-08183

GEOLOGY AND GROUND-WATER RESOURCES OF THE COASTAL AREA OF GEORGIA.
Geological Survey, Atlanta, GA. Water Resources Div.
J. S. Clarke, C. M. Hacke, and M. F. Peck.
Georgia Geologic Survey Bulletin 113, 1990. 106p, 25 fig, 4 tab, 12 plates, 81 ref, 3 append.

Descriptors: *Coastal aquifers, *Geohydrology, *Geology, *Georgia, *Groundwater resources, Aquifer systems, Geothermal water, Groundwater mining, Groundwater quality, Permeability, Saline water intrusion, Salinity, Transmissivity.

Groundwater is the principle source of water in the 13-county coastal area of Georgia. Groundwater pumping in the coastal area is derived from 5 aquifers that range in depth from 5 to 1,000 ft below land surface. From shallowest to deepest, they are: the surficial, upper Brunswick, lower Brunswick, Upper Floridan, and Lower Floridan aquifers. The water-bearing properties of the aquifers are variable owing to vertical and lateral variations in lithology. The most productive aquifer is the Upper Floridan, from which well yields of 5000 to 10,000 gal/min are common, and the transmissivity is as high as 500,000 sq ft/day. Wells tapping the surficial and the upper and lower Brunswick aquifers yield from about 2 to 180 gal/min. Previous studies indicated that anomalously high groundwater temperatures occurred in the Brunswick area, which was attributed to upward leakage of water from deeper zones. During this study, geothermal gradients measured at six wells in Chatham County and one in Bryan County indicate that in wells < 700 ft deep, the geothermal gradient was better than normal, possibly indicating some upward flow. Although there appears to be an upward component of flow, the quantities probably are small resulting from the low permeability of the intervening confining units. (Lantz-PTT)
W91-08187

GROUND-WATER FLOW IN THE CENTRAL VALLEY, CALIFORNIA.
A. K. Williamson, D. E. Prudic, and L. A. Swain.
Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Professional Paper 1401-D, 1989. 127p, 44 fig, 11 tab, 124 ref, append.

Descriptors: *California, *Central Valley, *Geohydrology, *Groundwater movement, *Groundwater resources, *Water resources data, Agriculture, Flow profiles, Groundwater irrigation, Hydraulic

conductivity, Leakage, Maps, Model studies, Permeability.

The agricultural productivity of the Central Valley is dependent on the availability of water from irrigation. About 7.3 million acres of cropland in the Central Valley receives about 22 million acre-ft of irrigation water annually. One half of this irrigation water is supplied by groundwater. This large groundwater development during the past 100 years has had major impacts on the aquifer system, such as a decline in water levels, land subsistence, depletion of aquifer storage, and increase in recharge. The flow conditions before and during development were simulated on a regional scale using a three dimensional finite-difference flow model. The Central Valley is a large structural trough filled with poorly permeable marine sediments that are overlain by coarser continental sediments. More than 50% of the thickness of the continental sediments is composed of fine grained lenticular deposits that are discontinuous but are distributed throughout the stratigraphic section in the entire Central Valley. The concept presented here considers the entire thickness of the continental deposits as one aquifer system which has varying vertical leakage that depends on several factors, including the amount of fine grained sediments. The average horizontal hydraulic conductivity is about 6 ft/day, and the average thickness of the continental deposits is about 2400 feet. Irrigation use increased evapotranspiration about 9 million acre-ft/yr over its predevelopment value. The flow model constructed during this study was calibrated principally in accordance with the hydrologic data observed during 1961-75 because little predevelopment data were available for analysis. An explicit algorithm to simulate land subsidence was developed and calibrated. The simulated land subsidence was within 6% if the estimated observed volume; however, the time lag associated with this type of subsidence was not adequately simulated. Simulated water level changes averaged 2.6 and 12 feet higher than observed water level changes for the water table and the lower pumped zones. The simulations indicated that vertical leakage greatly increased from the predevelopment values as a result of water flowing through the more than 100,000 irrigation well casings that are open to different aquifer layers. The simulation results are shown on maps for comparison with observed hydrologic data. (Lantz-PTT)
W91-08191

2G. Water In Soils

ENHANCED BIODEGRADATION OF PESTICIDES IN THE ENVIRONMENT.
For primary bibliographic entry see Field 5G.
W91-07118

SPATIAL VARIABILITY OF APPARENT ELECTRICAL CONDUCTIVITY.
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Water and Land Resources.
For primary bibliographic entry see Field 7B.
W91-07221

SOIL REACTION AND ACIDIC DEPOSITION.
Colorado State Univ., Fort Collins. Dept. of Agronomy.
For primary bibliographic entry see Field 5B.
W91-07228

ACIDIC SULFATE SOILS.
Department of Agriculture, Bangkok (Thailand). Div. of Soils.
For primary bibliographic entry see Field 5B.
W91-07229

TRIAXIAL- AND UNIAXIAL-COMPRESSION TESTING METHODS DEVELOPED FOR EXTRACTION OF PORE WATER FROM UNSATURATED TUFF, YUCCA MOUNTAIN, NEVADA.
Colorado School of Mines, Golden. Dept. of Geology.
T. E. Mower, J. D. Higgins, and I. C. Yang.
IN: Proceedings of the Nuclear Waste Isolation in the Unsaturated Zone, FOCUS '89. September 17-21, 1989, Las Vegas, Nevada. American Nuclear Society, Inc., La Grange Park, IL. (1989). p 426-433, 7 fig, 2 tab, 12 ref.

Descriptors: *Aeration zone, *Data acquisition, *Geohydrology, *Interstitial water, *Nevada, *Radioactive waste disposal, *Soil water, *Tuff, *Unsaturated flow, *Yucca Mountain, Groundwater mining, Waste disposal.

To support the study of the hydrologic system in the unsaturated zone at Yucca Mountain, Nevada, two extraction methods were examined to obtain representative, uncontaminated pore water samples from unsaturated tuff. Results indicate that triaxial compression, which uses a standard cell, can remove pore water from nonwelded tuff that has an initial moisture content $>$ 11% by weight; uniaxial compression, which uses a specifically fabricated cell, can extract pore water from nonwelded tuff that has an initial moisture content $>$ 8% and from welded tuff that has an initial moisture content $>$ 6.5%. For the ambient moisture conditions of Yucca Mountain tuffs, uniaxial compression is the most efficient method of pore water extraction. (Author's abstract)
W91-07243

PREDICTION OF CADMIUM ACCUMULATION IN A HETEROGENEOUS SOIL USING A SCALED SORPTION MODEL.
Agricultural Univ., Wageningen (Netherlands). Dept. of Soil Science and Plant Nutrition.
For primary bibliographic entry see Field 5B.
W91-07274

APPROACH TO PROCESS IDENTIFICATION: APPLICATION TO SOLUTE TRANSPORT THROUGH CLAYS.
Universidad Politecnica de Cataluna, Barcelona (Spain). Escuela Tecnica Superior de Ingenieros de Caminos, Canales y Puertos.
J. Carrera, J. Samper, G. Galarza, and A. Medina.
IN: ModelCARE 90: Calibration and Reliability in Groundwater Modelling. IAHS Publication No. 195. International Association of Hydrological Sciences, Washington, DC. 1990. p 231-240. 5 fig, 1 tab, 14 ref. Empresa Nacional de Residuos S. A. (ENRESA) Grant No. TC0612.

Descriptors: *Advection, *Anion exchange, *Calibrations, *Clays, *Diffusion, *Diffusivity, *Dispersion, *Groundwater movement, *Model studies, *Porosity, *Solute transport, *Sorption, Chemical interactions, Data interpretation, England, Evaluation, Experimental data, Experimental design, Hydraulic conductivity, Model testing, Permeability, Physical properties, Pore size, Tracers.

Modeling of natural processes is composed of several interacting steps. One of the most important steps is conceptualization, which involves the identification of the processes that are considered relevant to the simulated output and the model structure. A number of laboratory experiments on the migration of various solutes through London clay samples was performed at Harwell Laboratories in England as part of an international model validation program (INTRAVAL). The experiments included both diffusion and advection-dispersion tests. In addition to diffusion and advection-dispersion processes, ion exclusion and exchange mechanisms were also taken into consideration. Three different conceptual models for simulating the Harwell experiments were proposed: a single, a double, and a triple porosity model. The main difference among the three proposed conceptual models arises from the way in which the processes (i.e. diffusion, advection-dispersion, ion exclusion and exchange) are interconnected, especially with regards to the porosity structure. The models were calibrated using automatic techniques and a comparison was made of their performances using several criteria. The results indicated that, while the simplest model was the most robust, the triple porosity model (i.e., more complex porosity structure) may have been a better representation of reality. The exercise shows that the proposed methodology was capable of identifying which processes are required to explain a given data set. (See also W91-07253) (Korn-PTT)
W91-07276

MODEL CALIBRATION AND SIMULATION OF FLOW IN A HETEROGENEOUS SOIL.
HydroGeoLogic, Inc., Herndon, VA.
For primary bibliographic entry see Field 7C.
W91-07285

MODELLING SOIL MOISTURE MOVEMENT FOLLOWING DRIP IRRIGATION OF SUGAR CANE.
Institute of Hydrology, Wallingford (England).
For primary bibliographic entry see Field 3F.
W91-07291

STOCHASTIC ASPECTS OF NONPOINT NITRATE LEACHING FROM AGRICULTURAL FIELDS.
Hohenheim Univ., Stuttgart (Germany, F.R.). Inst. fuer Bodenkunde und Standortslehre.
For primary bibliographic entry see Field 5B.
W91-07296

HOW EFFECTIVE ARE EFFECTIVE MEDIUM PROPERTIES.
INTERA, Inc., Austin, TX.
S. Mishra, J. L. Zhu, and J. C. Parker.
IN: ModelCARE 90: Calibration and Reliability in Groundwater Modelling. IAHS Publication No. 195. International Association of Hydrological Sciences, Washington, DC. 1990. p 521-528. 3 fig, 1 tab, 11 ref. USDA-ARS Contract No. 58-3615-7-003.

Descriptors: *Groundwater transport, *Heterogeneity, *Hydraulic conductivity, *Hydraulic properties, *Model studies, *Soil properties, *Soil water, *Unsaturated flow, Boundary conditions, Calibrations, Correlation analysis, Data interpretation, Differential equations, Effective capacity, Flow equations, Homogeneity, Infiltration rate, Mathematical analysis, Mathematical equations, Mathematical studies, Monte Carlo method, Optimization, Prediction, Simulation, Statistical analysis, Statistical methods, Stochastic process, Uncertainty, Water level.

Spatial variability in natural soil materials is often an impediment to field-scale modeling of unsaturated flow and transport processes because of increased data requirements and computational burden. An alternative approach is based on treating the actual heterogeneous medium as an equivalent homogeneous system with a set of effective properties. Effective medium properties (i.e., moisture capacity, hydraulic conductivity, and hydraulic head) of heterogeneous media were derived using a perturbation expansion of Richard's equation. The effective medium properties were numerically evaluated from fine-scale simulations using a Monte Carlo methodology. The deviation in behavior of the effective homogeneous system from that of the actual heterogeneous system as a result of progressively coarsening grids was also investigated. Critical assumptions used for the study included a two-dimensional flow with one-dimensional boundary conditions and the absence of any long-range correlation relative to the scale of the simulations. The results of the investigation suggested that, for heterogeneous media with small spatial variability and correlation lengths, effective properties could be used for modeling transient unsaturated flow. Application of these parameters when the mesh was progressively coarsened did not appear to cause a significant difference between heterogeneous and equivalent homogeneous responses. In addition, reasonably accurate predictions of flow could be made with effective properties even when they were used in conjunction with coarser meshes where the number of grid blocks was reduced from the base case by as much as 50 percent. (See also W91-07253) (Korn-PTT)
W91-07304

VERIFICATION OF QUICK CAPILLARY RISE APPROACH FOR DETERMINING PORE GEOMETRICAL CHARACTERISTICS IN SOILS OF VARYING TEXTURE.
Haryana Agricultural Univ., Hissar (India). Dept. of Soils.
S. Kumar, and R. S. Malik.
Soil Science SOSCAK, Vol. 150, No. 6, p 883-888, December 1990. 2 fig, 1 tab, 15 ref.

Descriptors: *Capillarity, *Capillary action, *Quick capillary rise, *Soil physical properties, *Soil porosity, *Soil texture, *Soil water, Boundary conditions, Desorption, Hydraulic conductivity, Mathematical models, Model studies, Regression analysis, Soil types, Wetting.

Capillary rise experiments were conducted with water in soils of varying texture to verify the validity of the recently proposed Quick Capillary Rise (QCR) approach, by using straight line plots obtained between wetting front rise velocity dZ/dt and the inverse of the wetting front rise 1/Z in the first time segment. The values of the penetration coefficient delta and hydraulic conductivity derived from the QCR approach matched those measured independently. Equivalent pore radius predicted from the QCR approach was found to be higher and linearly related to mean pore radius determined experimentally from the soil water desorption curve. The values of pore shape factor ranged from 121 to 138 in different soils. Soil wettability in terms of cosine alpha decreased with fineness in soil texture in both QCR and Hammond and Yuan methods. The wetting front potential was found to be much lower than the apparent maximum height of capillary rise. These results show that the simple and inexpensive QCR approach may be used to determine geometrical, contact, and hydraulic characteristics in soils of varying texture. (Author's abstract)
W91-07334

MAXIMAL CAPILLARY RISE FLUX AS A FUNCTION OF HEIGHT FROM THE WATER TABLE.
New York State Coll. of Agriculture and Life Sciences, Ithaca. Dept. of Agricultural and Biological Engineering.
J.-Y. Parlange, R. Haverkamp, J. L. Starr, C. Fuentes, and R. S. Malik.
Soil Science SOSCAK, Vol. 150, No. 6, p 896-898, December 1990. 1 tab, 7 ref.

Descriptors: *Capillarity, *Capillary action, *Groundwater movement, *Mathematical models, *Soil water, *Water table, Boundary conditions, Hydraulic conductivity, Model studies, Saturated soils, Soil columns, Wetting.

In capillary rise experiments, after some initial time had elapsed the logarithm of the flux entering the soil column was linearly related to the position of the wetting front. The unsaturated hydraulic conductivity is taken from a Gardener expression which tends to break down near saturation. The need for a straight suction (h) near saturation was also required to describe infiltration properly. Using Richard's equation at time t = 0 when the soil is initially dry. By integrating the equation and allowing h to approach infinity, the wetting front of Malik's equation is obtained. Predictions were compared to experimental values and the agreement is good. Although the basic assumption is crude, the linear relationship is accurate. The observations of Malik et. al. can be justified very generally and a theoretical expression obtained which is not limited to low values of qm/ks. (Brunone-PTT)
W91-07335

EFFECT OF SOIL PROPERTIES ON UNSATURATED HYDRAULIC CONDUCTIVITY PORE-INTERACTION FACTORS.
North Dakota State Water Commission, Bismarck.
W. M. Schuh, and R. L. Cline.
Soil Science Society of America Journal SSSJD4, Vol. 54, No. 6, p 1509-1519, November/December 1990. 8 fig, 3 tab, 32 ref, append.

Descriptors: *Aeration zone, *Hydraulic conductivity, *Soil physical properties, *Soil porosity, *Soil water, *Unsaturated flow, Density, Drainage, Mathematical models, Parameter estimation, Particle size, Regression analysis, Soil series, Soil texture, Topography.

The variability of the pore-interaction factor, rho, for a microscopic model proposed for predicting unsaturated hydraulic conductivity, K(theta), from soil water-retention psi(theta), data was examined in relation to soil particle-size data and indices, bulk density, organic carbon, parameters for the van Genuchten psi(theta) function, an index(W) of total energy of drainage and soil-series, toposequential, and geographic groupings. The rho exhibited no trend relationship to any of the soil properties tested. However, a change in the distribution of rho was observed in relation to the geometric-mean particle diameter (Gd) and other soil textural variables. For Gd < 0.08 mm, variability was much larger than for soils with Gd >= 0.08 mm. The latter consisted entirely of soils in the sand and loamy sand textural groups. A similar distributional relationship also occurred for rho vs. W. Examination of rho on three sites of the Hecla soil series and on related toposequential soils indicated that classification of rho on the basis of soil series or of soil-association groupings is a feasible strategy for rho parameter estimation on some soils. The exponential factor nu for a macroscopic model was also investigated and was found to be related to W as an exponential function over the full data range. However nu vs. W was nearly identical to a linear function for W data extending from 0 to 400 cm-gamma (where gamma is the density of water). The nu was also strongly related to Gd as a power function, and to other textural variables as exponential functions. The increasing slope of the power function for Gd < 0.08 mm indicated a large potential error of prediction for K(theta) on fine-textured soils. (Author's abstract)
W91-07336

SIMULATING WATER MOVEMENT IN LAYERED AND GRADATIONAL SOILS USING THE KIRCHOFF TRANSFORM.
Commonwealth Scientific and Industrial Research Organization, Townsville (Australia). Div. of Soils.
P. J. Ross, and K. L. Bristow.
Soil Science Society of America Journal SSSJD4, Vol. 54, No. 6, p 1519-1524, November/December 1990. 4 fig, 2 tab, 9 ref, append.

Descriptors: *Mathematical models, *Model studies, *Soil horizons, *Soil water, Flow equations, Groundwater movement, Hydraulic conductivity, Kirchoff transform, Ponding, Soil physical properties, Soil profiles, Water table.

Changes in soil hydraulic properties with depth are common in field soils and need to be accounted for in simulations of field soil-water balances. This accounting is possible using the Kirchoff transform (K transform) when solving Richards' equation numerically, even though the K transform is not continuous across boundaries between layers with different hydraulic properties. The solution is achieved by dividing the soil into depth elements, using the K transform to compute flow within each element, and then using matric potential (which is continuous across boundaries) to couple the elements. Combination of the K transform with iterative, implicit, mass conserving methods of solving the flow equations results in efficient solutions that take no more than a few seconds on a personal computer to simulate infiltration, with errors of only a few percent in the amount and distribution of soil water. Simulation was shown for infiltration into a layered profile consisting of tilled soil with a crust overlaying an undisturbed soil, and gradational profiles with hydraulic properties of a sand varying linearly with depth to those of a clay, and conversely. Development and dissipation of surface ponding and perched water tables during simulation runs presented no difficulties, nor did use of the Campbell formulations for the soil hydraulic properties, despite the discontinuity at the wet end. (Author's abstract)
W91-07337

PREDICTING CATION MOBILITY IN MONTMORILLONITIC MEDIA BASED ON EXCHANGE SELECTIVITIES OF MONTMORILLONITE.
Louisiana State Univ., Baton Rouge. Dept. of Agronomy.
L. A. Gaston, and H. M. Selim.
Soil Science Society of America Journal SSSJD4, Vol. 54, No. 6, p 1525-1530, November/December 1990. 7 fig, 2 tab, 20 ref. NSF Grant INT-8713283.

Descriptors: *Cation exchange, *Montmorillonite, *Soil chemistry, *Soil types, *Soil water, Calcium, Comparison studies, Groundwater movement, Magnesium, Mathematical models, Selectivity coefficients, Sodium.

Cation-exchange reactions influence the distribution of species between soil solution and sorbed phases and, in turn, the rate of movement of species through the soil. This study was undertaken to determine whether cation-exchange selectivity coefficients of montmorillonite could be used to adequately describe cation movement in a montmorillonitic soil. Literature data for Ca-Mg, Ca-Na, and Mg-Na exchange on pure montmorillonite in ClO4 and Cl anionic backgrounds were used to calculate average values for binary exchange selectivity coefficients. These selectivity coefficients were subsequently used in transport models in attempts to describe experimental binary (Ca-Mg or Ca-Na) and ternary (Ca-Mg-Na) miscible displacement in columns of bulk montmorillonite (admixed with sand) and Sharkey clay soil (a very fine montmorillonitic, non-acid, thermic Vertic Haplaquept) from Louisiana. In general, use of Ca-Mg exchange selectivity coefficients produced transport simulations in good agreement with experimental results. Use of heterovalent exchange coefficients tended to predict somewhat later breakthroughs of Na than were observed. Although cation-exchange selectivities of montmorillonite could be used to adequately describe Ca, Mg and Na transport in Sharkey soil, generalization of these results requires additional confirmation using other montmorillonitic soils. (Author's abstract)
W91-07338

INITIAL STORM EFFECTS ON MACROPORE TRANSPORT OF SURFACE-APPLIED CHEMICALS IN NO-TILL SOIL.
Agricultural Research Service, Coshocton, OH. North Appalachian Experimental Watershed.
For primary bibliographic entry see Field 5B.
W91-07339

STATISTICAL PARAMETERS CHARACTERIZING THE SPATIAL VARIABILITY OF SELECTED SOIL HYDRAULIC PROPERTIES.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental and Hazardous Material Studies.
For primary bibliographic entry see Field 7C.
W91-07340

ANALYTICAL EXPRESSION FOR SOIL WATER DIFFUSIVITY DERIVED FROM HORIZONTAL INFILTRATION EXPERIMENTS.
Arizona Univ., Tucson. Dept. of Soil and Water Science.
J. J. Meyer, and A. W. Warrick.
Soil Science Society of America Journal SSSJD4, Vol. 54, No. 6, p 1547-1552, November/December 1990. 5 fig, 1 tab, 20 ref. Western Regional Project W-155.

Descriptors: *Diffusivity, *Infiltration capacity, *Mathematical models, *Model studies, *Soil water.

A technique is developed that utilizes a rational function theta = (A1 + (A-3)(delta)/(1 + (A2)(delta)) to fit water content (or other liquid) profiles resulting from horizontal infiltration as used in the Bruce-Klute method for determining soil water diffusivity. In the above function, theta is water content, delta is the Boltzmann variable, and A-1, A-2, and A-3 are constants. To Boltzmann variable, delta, is equal to the distance from the inlet of a horizontal soil column times the time from the commencement of liquid imbibition to the

0.5 power. The function is easy to fit to experimental data by either linear or nonlinear regression techniques and leads to analytical expressions for sorptivity and soil water diffusivity without further numerical approximation or fitting. If boundary conditions are specified, only one of the three coefficients is left to be determined. The rational function provided excellent approximations to liquid distribution for water and alcohol horizontal infiltration experiments in this study and is adequate for representation of the experimental data of several other researchers. (Author's abstract)
W91-07341

FIELD STUDY USING DYES TO CHARACTERIZE PREFERENTIAL FLOW OF WATER.
Delaware Univ., Newark. Dept. of Plant Science.
M. Ghodrati, and W. A. Jury.
Soil Science Society of America Journal SSSJD4, Vol. 54, No. 6, p 1558-1563, November/December 1990. 6 fig, 19 ref.

Descriptors: *Field tests, *Soil water, *Tracers, Dyes, Flow profiles, Irrigation, Soil physical properties, Solutes, Spatial distribution.

Characterization of preferential flow in soils through normal water tracer studies are, in most cases, inconclusive because of the inability of most solute sampling devices to detect the spatial pattern of preferential flow pathways. A number of field-plot experiments were performed to provide direct observation of the preferential flow of water and solutes by adding soluble dye to stain the flow pathways. In addition to characterizing the spatial structure of preferential flow pathways, the dye trace patterns were used to investigate the interactive role of soil structure and irrigation methods on the preferential flow patterns of water and solutes. A narrow pulse of an anionic water-soluble dye, Acid-Red 1, was applied to the surface of a number of 1.5 by 1.5 m plots, some of which had the top layer completely disturbed to the depth of 30 to 40 cm. The distribution patterns of the dye in these plots were examined after the plots received 100 mm of irrigation water, under either ponding or daily sprinkler irrigation. The observed vertical and horizontal distribution patterns of the water-soluble dye clearly indicated the preferential flow patterns for each experimental condition. These include vertical fingering of dye traces 5 to 20 cm wide, which extended more than twice as deep as the mean displacement of the dye, as well as isolated patches of dye indicating lateral flow. (Author's abstract)
W91-07342

KINETICS OF SULFATE DESORPTION FROM SOIL.
Agricultural Research Service, Durant, OK. Water Quality and Watershed Research Lab.
A. N. Sharpley.
Soil Science Society of America Journal SSSJD4, Vol. 54, No. 6, p 1571-1575, November/December 1990. 3 fig, 4 tab, 57 ref.

Descriptors: *Acid rain, *Acid rain effects, *Desorption, *Kinetics, *Mathematical models, *Path of pollutants, *Soil chemistry, *Soil water, *Sulfates, Agriculture, Runoff, Separation techniques, Surface runoff.

Sulfate desorption and mobility in soil can be of both environmental and agronomic importance. The desorption of sulfate from agricultural soils was described under experimental conditions applicable to the movement of sulfate in overland flow and runoff waters. The kinetics of sulfate desorption from soil were investigated at five different water/soil ratios (10:1 to 400:1), five time periods (5 to 180 minutes), and four sulfate additions (0 to 200 mg/kg). Sulfate desorption (Sd) was logarithmically related to contact time and water/soil ratio and was a linear function of the initial extractable sulfate of soil (Sc). The kinetics of sulfate desorption was described by the equation Sd = (K)(Sc)(t-alpha)(W-beta), where K, alpha, beta are constants for a given soil. This equation has previously been shown to describe desorption of soil P and K. The kinetic constants, K (r squared = 0.88), alpha (r squared = 0.83), and beta (r squared = 0.88) were related to extractable soil Al content for 107 US soils. The uniformity of equation constants for a given soil and the ease with which they can be estimated from extractable soil Al indicate the potential use of the equation in modeling sulfate desorption from soil and subsequent movement in surface runoff water. (Author's abstract)
W91-07344

PHOSPHORUS CHEMISTRY AND MINERALOGY IN EXCESSIVELY FERTILIZED SOILS: SOLUBILITY EQUILIBRIA.
Kansas State Univ., Manhattan. Dept. of Agronomy.
G. M. Pierzynski, T. J. Logan, and S. J. Traina.
Soil Science Society of America Journal SSSJD4, Vol. 54, No. 6, p 1589-1595, November/December 1990. 5 fig, 5 tab, 31 ref.

Descriptors: *Fertilizers, *Phosphorus, *Soil chemistry, Agriculture, Equilibrium, Groundwater movement, Hydrogen ion concentration, Ion exchange, Manure, Sludge, Soil types, Solubility.

Eleven samples representing six soil series were selected for this study of excessively fertilized soils. Phosphorus sources included fertilizers, sewage sludges, and manures. The samples had Bray Pl extractable P levels ranging from 29 to 640 mg P/kg and 1:1 soil/water pH values ranging from 5.4 to 7.4. The equivalent of 25 g of dry soil and 50 ml of water were incubated at 298 K. Samples were sacrificed for analysis periodically during the 130 day test period. The activities of most ions, as estimated with GEOCHEM, were relatively constant throughout the course of the experiment. The concentrations of organic and inorganic carbon for samples that had been amended with sewage sludges or manures varied considerably during the course of the experiment. Samples that produced high supernatant pH values (> 6.8) generally were more soluble than hydroxyapatite and less soluble than octacalcium phosphate and were slow in attaining constant ion activity products relative to the Ca phosphate minerals considered. Samples that produced low supernatant pH values (< 6.8) indicated an equilibrium with the amorphous analog of variscite throughout the experiment. (Author's abstract)
W91-07345

SOIL DENITRIFICATION AND NITRIFICATION POTENTIALS DURING THE GROWING SEASON RELATIVE TO TILLAGE.
Agricultural Research Service, Beckley, WV. Appalachian Soil and Water Conservation Research Lab.
For primary bibliographic entry see Field 3F.
W91-07346

SPATIAL VARIATION IN DENITRIFICATION: DEPENDENCY OF ACTIVITY CENTERS ON THE SOIL ENVIRONMENT.
Copenhagen Univ. (Denmark). Inst. of Population Biology.
For primary bibliographic entry see Field 3F.
W91-07347

TEMPORAL PATTERNS OF SOIL DENITRIFICATION: THEIR STABILITY AND CAUSES.
Copenhagen Univ. (Denmark). Inst. of Population Biology.
For primary bibliographic entry see Field 3F.
W91-07348

STEADY-STATE AEROBIC MICROBIAL ACTIVITY AS A FUNCTION OF SOIL WATER CONTENT.
Nebraska Univ., Lincoln. Dept. of Agronomy.
J. Skopp, M. D. Jawson, and J. W. Doran.
Soil Science Society of America Journal SSSJD4, Vol. 54, No. 6, p 1619-1625, November/December 1990. 6 fig, 2 tab, 28 ref.

Descriptors: *Microorganisms, *Soil physical properties, *Soil water, Diffusion coefficient, Mathematical models, Model studies, Moisture content, Oxygen, Soil aeration, Soil management, Soil porosity, Tillage.

Soil physical properties often regulate aeration-dependent microbial activities important to nutrient cycling, soil fertility and environmental quality. Microbial activity depends on soil water content and is maximum at a water content where the limiting effects of substrate diffusion and oxygen supply are equal. The shape of the microbial activity versus water content function was estimated from soil physical concepts. Soil physical processes are assumed to influence microbial activity by limiting the steady flux of a required substrate or oxygen to sites of microbial activity. The dependence of diffusion coefficient on water content or air-filled porosity is assumed. With these assumptions, a maximum in the activity function exists. The predicted shape of the activity curve is consistent with experimental observations. The relationship between aeration-dependent microbial activity and soil water content facilitates evaluating the indirect effects of soil management practices, such as tillage, on microbial activity. (Author's abstract)
W91-07349

MODELING WATER BALANCE AND GRASS PRODUCTION.
Agriculture Canada, Ottawa (Ontario). Land Resource Research Centre.
For primary bibliographic entry see Field 3F.
W91-07353

INFILTRATION IN ADJACENT CECIL AND PACOLET SOILS.
Georgia Univ., Athens. Dept. of Agronomy.
D. E. Radcliffe, L. T. West, G. O. Ware, and R. R. Bruce.
Soil Science Society of America Journal SSSJD4, Vol. 54, No. 6, p 1739-1743, November/December 1990. 3 fig, 3 tab, 23 ref.

Descriptors: *Crop yield, *Infiltration, *Soil erosion, *Soil types, *Soybeans, Hydraulic conductivity, Infiltrometers, Runoff, Saturated soils, Soil horizons, Soil water.

Cecil (clayey kaolinitic, thermic Typic Kanhapludult) and associated soils cover two-thirds of the land area of the Southern Piedmont. Soybean (Glycine max) yields from severely eroded sites in these soils are about half of those from slightly eroded sites. Most of the severely eroded sites are on the Pacolet soil series (clayey kaolinitic, thermic, Typic Kanhapludult), which is shallower to the bottom of the Bt horizon. Differences in infiltration rates may cause these differences in yield. Infiltration rate differences between Cecil and Pacolet soils were quantified and evaluated. Infiltration rate was measured using a cylinder infiltrometer at five sites with adjacent Cecil and Pacolet soils, and using a sprinkler infiltrometer at one site. Steady-state infiltration in the Pacolet was significantly lower than in the Cecil, 4.2 and 30.1 mm/hour, respectively. Cecil infiltration rates increased as depth to the Bt horizon increased. On Cecil, final sprinkler infiltration rate was 61.1 mm/hour with a sod surface, but surface sealing reduced infiltration with a bare surface to 3.6 mm/hour within 1 hour. The final sprinkler-infiltration rates of the Pacolet soil were 4.5 mm/hour for sod and 4.2 mm/hour for bare surfaces. Pacolet infiltration rates were controlled by the Bt1 layer, which had a lower, saturated hydraulic conductivity (2.3 mm/hour) and fewer mesopores than adjacent horizons but was similar to the upper Bt of the Cecil soil. The Cecil soil's limiting Bt1 horizon occurred much deeper in the profile and had less effect on infiltration. Areas of Pacolet within the Cecil landscape, too small to map separately, can cause increased runoff and variability of yield potential of areas mapped at Cecil. (Author's abstract)
W91-07355

TILLAGE AND CROP ROTATION EFFECT ON CHARACTERISTICS OF A SANDY SURFACE SOIL.
Southern Piedmont Conservation Research Center, Watkinsville, GA.
R. R. Bruce, G. W. Langdale, and A. L. Dillard.
Soil Science Society of America Journal SSSJD4,

Vol. 54, No. 6, p 1744-1747, November/December 1990. 5 tab, 16 ref.

Descriptors: *Crop rotation, *Soil physical properties, *Soil types, *Tillage, Aggregates, Climates, Crop yield, Density, Infiltration, Particle size, Seasonal distribution, Soil porosity, Sorghum, Soybeans, Wheat.

In a thermic udic region, a summer crop species may be planted with or without tillage subsequent to a winter grain crop that was planted into a prepared seedbed. The effect of tillage intensity was tested in association with soybean (Glycine max) and grain sorghum (Sorghum bicolor) crop sequences following winter wheat (Triticum aestivum), and the effect of summer crop species on selected physical characteristics of a Cecil sandy loam (clayey, kaolinitic, thermic Typic Kanhapludult). Through eight seasons, soybean and grain sorghum were grown in 10 crop sequences that were imposed on three tillage treatments: conventional tillage (CT), in-row chisel (MT), and no-tillage (NT). Following summer crop harvest in the eighth season, aggregate stability, organic carbon, bulk density, air-filled pore space, particle-size distribution, and infiltration of water were measured. Aggregate stability at 0 to 10 mm was significantly higher for MT and NT than for CT. The CT treatment exhibited significantly lower bulk density and higher air-filled pore space, and lower bulk density were measured after two or more years of grain sorghum than after soybean. The maintenance of wheat straw on the soil surface under the MT and NT treatment exhibited an effect to a depth of 75 mm and the in-row chisel treatment affected infiltration. Crop-rotational effects can be erased or modified by tillage and may only be observed under NT. Grain yield response of soybean and grain sorghum to changes in soil physical characteristics, as a consequence of crop sequence and tillage, may need to be interpreted in relation to crop species and cropping sequence. (Author's abstract)
W91-07356

CATION REMOVAL DURING APPLICATION OF ACID SOLUTIONS INTO AIR-DRY SOIL COLUMNS.
NSI Technology Services Corp., Ada, OK.
For primary bibliographic entry see Field 5B.
W91-07357

ALUMINUM AND ORGANIC MATTER MOBILIZATION FROM SOIL INFILTRATED WITH ACIDIFIED CALCIUM SULFATE SOLUTIONS.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Crop and Soil Environmental Sciences.
D. F. Berry, L. W. Zelazny, and H. L. Walker.
Soil Science Society of America Journal SSSJD4, Vol. 54, No. 6, p 1757-1762, November/December 1990. 5 fig, 3 tab, 21 ref.

Descriptors: *Acid rain, *Acid rain effects, *Aluminum, *Calcium, *Chemistry of precipitation, *Organic matter, *Path of pollutants, *Soil chemistry, *Soil water, Cation exchange, Forest soils, Groundwater movement, Hydrogen ion concentration, Leaching, Precipitation, Soil horizons.

Investigations of acid rain effects on forest soils have generally overlooked calcium, a major component of precipitation. The effects of calcium on the mobilization of aluminum and organic matter were determined in a Cecil clay (a clayey, kaolinitic, thermic Typic Kanhapludult). Acidic solutions (pH 4.2) containing ambient or near-ambient precipitation concentrations of calcium, potassium, and sulfate were used to infiltrate columns containing Oa, EB, or Oa/EB bihorizon soil material. Leachate was analyzed for dissolved organic carbon, Al, Ca, K, and H ions. A net release of protons was observed when the Oa surface horizon was infiltrated with 0.05 mol/cubic m CaSO4 or 0.25 mol/cubic m CaSO4 or K2SO4 leaching solutions, but not 0.05 mol/cubic m K2SO4 solution. Infiltration of Oa horizon soil with calcium solutions resulted in the release of more protons than with K solutions of comparable ionic strength. Calcium leaching solutions were also more effective than K solutions (7.7% and 28% for 0.05 and 0.25 mol/cubic m solutions, respectively) in mobilizing aluminum from Oa/EB bihorizon soils. These differences were not found in EB horizon soils treated with the same leaching solutions. These results suggest that CaSO4 leaching solutions, at concentration levels consistent with those in precipitation, displaced protons from the Oa horizon, which subsequently infiltrated the underlying EB horizon causing increased solubilization of aluminum. While some aluminum was undoubtedly associated with organic matter, overall, movements of aluminum and organic matter in Oa/EB bihorizon soil columns were found to be independent of one another. (Author's abstract)
W91-07358

PHOSPHORUS AND ALUMINUM RELEASE FROM A SPODIC HORIZON MEDIATED BY ORGANIC ACIDS.
ITT Rayonier, Inc., Yulee, FL. Forest Research Center.
T. R. Fox, N. B. Comerford, and W. W. McFee.
Soil Science Society of America Journal SSSJD4, Vol. 54, No. 6, p 1763-1767, November/December 1990. 3 fig, 3 tab, 34 ref.

Descriptors: *Aluminum, *Organic acids, *Phosphorus, *Soil chemistry, *Soil horizons, Complexation, Hydrogen ion concentration, Nutrients, Plant physiology, Soil types.

The ability of organic acids to affect surface and solution reactions of phosphorus and aluminum in soils containing aluminum-oxide surfaces is related to their ability to form stable complexes with aluminum. The amount of phosphorus and aluminum released following the addition of an organic acid to a Bh horizon soil could be estimated based on the aluminum stability constant (logK-Al) of the organic acid. The release of aluminum and inorganic phosphorus from spodic horizon material increased in the presence of organic acids that form stable complexes with aluminum. Overall, the logK-Al value was a good indicator of the effect of the organic acid on inorganic phosphorus and aluminum release. Among the sixteen organic acids studied, release of aluminum and inorganic phosphorus increased exponentially with increasing stability constants. A threshold value of approximately 4.1; however, was required before substantial amounts of inorganic phosphorus were released. This value may reflect the stability of phosphorus bond to aluminum-oxide surfaces in this soil. Salicylic acid was a notable exception to the observed trend in release of both aluminum and phosphorus; despite a large stability constant, little inorganic phosphorus or aluminum was released. Although significant amounts of soluble organic phosphorus were released in all the organic-acid solutions, the amount of soluble organic phosphorus released was not related to the stability constant of the organic acids. These results indicate that soluble organic phosphorus may make a substantial contribution to the amount of plant-available phosphorus in this soil. (Author's abstract)
W91-07359

NEW TECHNIQUE FOR MEASURING VOLUMETRIC SHRINKAGE IN SOILS.
Rocky Mountain Forest and Range Experiment Station, Tempe, AZ. Forestry Sciences Lab.
For primary bibliographic entry see Field 7B.
W91-07360

EFFECTS OF ACIDIC DEPOSITION ON THE CHEMICAL FORM AND BIOAVAILABILITY OF SOIL ALUMINUM AND MANGANESE.
DowElanco, Midland, MI. Environmental Chemistry Lab.
For primary bibliographic entry see Field 5C.
W91-07468

RATES OF NUTRIENT RELEASE BY MINERAL WEATHERING.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Crop and Soil Environmental Sciences.
For primary bibliographic entry see Field 5B.
W91-07469

EFFECTS OF ACIDIC DEPOSITION ON SOIL ORGANISMS.
Oregon State Univ., Corvallis. Dept. of Soil Science.
For primary bibliographic entry see Field 5C.
W91-07470

ATMOSPHERE AND THE RHIZOSPHERE: LINKAGES WITH POTENTIAL SIGNIFICANCE FOR FOREST TREE HEALTH.
Yale Univ., New Haven, CT. School of Forestry and Environmental Studies.
W. H. Smith.
IN: Mechanisms of Forest Response to Acidic Deposition. Springer-Verlag New York, Inc., New York. 1990. p 188-241. 4 fig, 9 tab, 130 ref. USDA Cooperative Agreement 23-993 and Competitive Grant 85-CRCR-1-1807.

Descriptors: *Acid rain, *Acid rain effects, *Acidic soils, *Acidification, *Forest soils, *Rhizosphere, *Root zone, *Soil organisms, Cycling nutrients, Forest ecosystems, Microorganisms, Plant physiology, Reviews, Soil contamination, Soil properties, Trees.

The direct and indirect consequences of atmospheric deposition on plant root physiology and on the ecology of microbiota in the immediate vicinity of roots are two of the most important aspects of the study of the possible influence of atmospheric contaminants on the ecology of soil biota and on the processes of nutrient cycling in forest ecosystems. The rhizosphere is the very restricted zone of soil immediately surrounding plant roots. The dominant feature and primary characteristic of rhizosphere soil relative to bulk soil is the stimulation of microbial numbers and activity in the former zone. The rhizosphere effect is based principally on microbial stimulation in the near-root environment, which is primarily the result of the abundance of nutritional substrates in the vicinity of roots relative to bulk soil. The complex interaction between plant roots and microorganisms in the rhizosphere produces a biologically, chemically, and physically unique soil environment of enormous consequence to plant health. Six hypotheses from current literature describing potential impacts of atmospheric deposition on the nature and functions of soil near roots are discussed. These six are: (1) alteration of rhizosphere chemistry by aboveground stress; and alterations to rhizosphere regulation of (2) nutrient uptake; (3) heavy metal uptake; (4) aluminum uptake; (5) habitat of microbes controlling nutrient uptake; and (6) pathogen and saprophyte ecology. It is concluded that the rhizosphere region of soil exerts dominant regulation over nutrient uptake by roots, root disease from biotic infection, and microbial saprophyte and symbiont ecology. It is, therefore, critically essential to evaluate the potential interactions between pollutants deposited to forests from the atmosphere and rhizosphere structure and function. (See also W91-07465) (VerNooy-PTT)
W91-07471

ROLE OF GEOLOGY AND SOILS IN CONTROLLING SURFACE WATER ACIDITY IN WALES.
Institute of Terrestrial Ecology, Grange-over-Sands (England). Merlewood Research Station.
For primary bibliographic entry see Field 5B.
W91-07476

DISSOLVED INORGANIC ALUMINUM IN ACIDIC STREAM AND SOIL WATERS IN WALES.
Institute of Hydrology, Wallingford (England).
For primary bibliographic entry see Field 5B.
W91-07483

ECOLOGICAL BACKGROUND, DETERIORATION AND RECLAMATION OF DESERT DUNE SAND.
Ben-Gurion Univ. of the Negev, Beersheba

(Israel). Dept. of Geography.
H. Tsoar.
Agriculture, Ecosystems and Environment AEENDO, Vol. 33, No. 2, p 147-170, December 1990. 13 fig, 1 tab, 61 ref.

Descriptors: *Agricultural practices, *Arid lands, *Deserts, *Irrigation practices, *Literature review, *Sand, *Soil erosion, *Soil management, *Soil-water-plant relationships, Brackish water, Drip irrigation, Fertilizers, Leaching, Rainfall, Soil analysis, Thermal retention, Vegetation effects.

The physical properties of desert dune sand are part of its ecological characteristics. Sandy soils are known for their superiority to finer soils in deserts. For this reason, sand dunes in arid lands are covered, as a natural process, by vegetation. The drawback of sand is its mobility; erosion of sand, not lack of moisture, is the major limiting factor for vegetation on dunes. The destruction of vegetation by overgrazing and by being collected for firewood and building material is a relatively quick process. This stimulates sand movement and increases deterioration through positive feedback. While deterioration processes are swift, natural reclamation processes are slow. One way of increasing the productivity of dune sand is by the use of sophisticated methods of agriculture. Unlike sand in humid areas, sand in deserts offers many advantages for agriculture; it is the only soil that endures irrigation with brackish water, and its thermal retention forces crops to ripen quickly. The problem of low and unreliable rainfall in arid lands can be turned to advantage by the use of the drip irrigation method, which allows a rational and economic use of fertilizers without the risk of leaching by subsequent rain. (Author's abstract)
W91-07548

PARAMETER ESTIMATION FOR SIMULATING BINARY HOMOVALENT CATION TRANSPORT IN AGGREGATED SOILS AT VARIABLE IONIC STRENGTH.
Eidgenoessische Technische Hochschule, Zurich (Switzerland). Lab. of Soil Physics.
For primary bibliographic entry see Field 5B.
W91-07580

ION CHROMATOGRAPHY OF FRESH AND SALT-WATER DISPLACEMENT: LABORATORY EXPERIMENTS AND MULTICOMPONENT TRANSPORT MODELLING.
Vrije Univ., Amsterdam (Netherlands). Inst. voor Aardwetenschappen.
For primary bibliographic entry see Field 5B.
W91-07581

LENGTH SCALES OF CONVECTION-DISPERSION APPROACHES TO FLOW AND TRANSPORT IN POROUS MEDIA.
Rutgers - The State Univ., New Brunswick, NJ. Dept. of Soils and Crops.
For primary bibliographic entry see Field 5B.
W91-07582

STATISTICAL AND GRAPHICAL METHODS FOR EVALUATING SOLUTE TRANSPORT MODELS: OVERVIEW AND APPLICATION.
California Univ., Berkeley. Dept. of Soil Science.
For primary bibliographic entry see Field 5B.
W91-07583

DETERMINISTIC AND STOCHASTIC MODELING OF REACTIVE SOLUTE TRANSPORT.
Agricultural Univ., Wageningen (Netherlands). Dept. of Soil Science and Plant Nutrition.
For primary bibliographic entry see Field 5B.
W91-07584

CONDITIONAL SIMULATION OF FLOW AND TRANSPORT.
Science and Education Administration, University Park, PA. Northeast Watershed Research Center.
For primary bibliographic entry see Field 5B.
W91-07585

TOWARD VALIDATING STATE-DEPENDENT MACROSCOPIC ANISOTROPY IN UNSATURATED MEDIA: FIELD EXPERIMENTS AND MODELING CONSIDERATIONS.
Washington State Univ., Pullman. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 5B.
W91-07587

MULTILABORATORY EVALUATION OF METHODS FOR DETECTING ENTERIC VIRUSES IN SOILS.
Environmental Protection Agency, Cincinnati, OH.
For primary bibliographic entry see Field 7B.
W91-07649

MAJOR REMEDIATION: REMOVAL AND RECOVERY OF TCE FROM SOIL AND GROUNDWATER.
Dames and Moore, Willow Grove, PA.
For primary bibliographic entry see Field 5G.
W91-07683

EFFECT OF FREEZE/THAW CYCLES ON THE PERMEABILITY OF A FINE-GRAINED SOIL.
Rensselaer Polytechnic Inst., Troy, NY. Dept. of Civil Engineering.
T. F. Zimmie, and C. La Plante.
IN: Hazardous and Industrial Wastes: Proceedings of the 22nd Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 580-593. 8 fig, 8 ref.

Descriptors: *Freeze-thaw tests, *Landfill covers, *Permeability, *Soil properties, *Soil water, *Waste containment, *Water pollution control, Clays, Land disposal, Landfills, Silty soils, Temperature effects, Weather.

When a landfill reaches its maximum capacity, it must be covered and secured. Current Resource Conservation and Recovery Act guidance for covers at uncontrolled hazardous waste and municipal solid waste sites specify that the cover will include a compacted soil component (typically clay) having a field permeability of .0000001 cm/second or less. Many factors impact the permeability of clay. One such potential factor is the effect of freezing and thawing. The present conservative approach is to cover the clay component of the cap with enough soil to prevent frost penetration into the clay. Depending on the climate, frost can penetrate as deep as 1.2 to 2.4 m in the Northeastern U.S. The effect of freeze/thaw cycles on the permeability of a Niagara Clay (silty clay) was examined. The soil samples were frozen and thawed one dimensionally, as well as three-dimensionally. Increases in permeability from their natural permeabilities were seen when clays were subjected to freeze/thaw cycles. The dry samples produced almost constant permeabilities after the first cycle, optimum moisture samples produced constant permeabilities after the fifth cycle, and wet samples after the tenth cycle. The dry samples increased approximately one and one half orders of magnitude, and the optimum and wet samples increased approximately one order of magnitude. One interpretation of these results is that the permeability results obtained both by one dimensional and three dimensional freezing are similar, for practical purposes. However, these results also indicate that more research should be done in the three dimensional area, especially utilizing different soil types. (See also W91-07662) (Mertz-PTT)
W91-07701

DRYLAND AGRICULTURE: STRATEGIES FOR SUSTAINABILITY.
For primary bibliographic entry see Field 3F.
W91-07752

CONSERVATION TILLAGE SYSTEMS.
Agricultural Research Service, Bushland, TX. Conservation and Production Research Lab.
For primary bibliographic entry see Field 3F.
W91-07755

TILLAGE AND RESIDUE MANAGEMENT EFFECTS ON SOIL ORGANIC MATTER DYNAMICS IN SEMIARID REGIONS.
Agricultural Research Service, Pullman, WA.
For primary bibliographic entry see Field 3F.
W91-07756

TILLAGE SYSTEMS AND EQUIPMENT FOR DRYLAND FARMING.
Agricultural Research Service, Bushland, TX. Conservation and Production Research Lab.
For primary bibliographic entry see Field 3F.
W91-07757

MANAGING CROP RESIDUES TO OPTIMIZE CROP/LIVESTOCK PRODUCTION SYSTEMS FOR DRYLAND AGRICULTURE.
Agricultural Research Service, Pullman, WA.
For primary bibliographic entry see Field 3F.
W91-07762

CONTRIBUTION OF SOIL CONSTITUENTS IN ADSORPTION COEFFICIENT OF AROMATIC COMPOUNDS, HALOGENATED ALICYCLIC AND AROMATIC COMPOUNDS TO SOIL.
Keio Univ., Yokohama (Japan). Faculty of Science and Technology.
For primary bibliographic entry see Field 5B.
W91-07839

LEVELS AND SOURCES OF PCDDS AND PCDFS IN URBAN BRITISH SOILS.
University of East Anglia, Norwich (England). School of Chemical Sciences.
For primary bibliographic entry see Field 5B.
W91-07840

SIMULATION OF THE SIZE DISTRIBUTION AND EROSIVITY OF RAINDROPS AND THROUGHFALL DROPS.
Silsoe Coll. (England).
For primary bibliographic entry see Field 2B.
W91-07849

TEMPORAL AND SPATIAL VARIABILITY OF SOIL MOISTURE RESERVES IN A FOREST-STEPPE LANDSCAPE (BASED ON KUREX 88 EXPERIMENT).
Akademiya Nauk SSSR, Moscow. Inst. Geografii.
A. G. Georgiadi, S. V. Yasinski, A. V. Meleshko, L. M. Kitaev, and V. I. Shadrin.
IN: Regionalization in Hydrology. IAHS Publication No. 191. International Association of Hydrological Sciences, Washington, DC. 1990. p 25-32, 7 fig, 1 tab, 4 ref.

Descriptors: *Air-water interfaces, *Forests, *Soil water potential, *Steppes, *USSR, Analysis of variance, Groundwater, Rainfall, Scale factors, Soil water, Statistical analysis, Vegetation effects.

Investigation of the interaction between atmospheric processes and heterogeneous land surfaces requires assessment of varying scale temporal and spatial variability of hydrological processes that exert a considerable influence on heat and moisture exchange in the atmosphere/land-surface system. The scale of spatial and temporal variability of soil moisture reserves was examined in the very heterogeneous landscapes of the central forest-steppe zone of the Russian plain. Two main scales of variability were determined in connection with infrageosystem and intergeosystem differences in soil and vegetation cover, and the relationship between soil and groundwater. A method for determination of the dynamics of soil moisture reserves for the main types of geosystems was developed, based on a statistical relationship between soil moisture reserves and daily rainfall. The equation takes account of spring recharge and average seasonal changes in moisture reserves over many years. (See also W91-07920) (Fish-PTT)
W91-07924

GROUNDWATER RECHARGE THROUGH THE UNSATURATED ZONE OF SOUTHEASTERN BOTSWANA: A STUDY OF CHLORIDES AND ENVIRONMENTAL ISOTOPES.
Botswana Univ., Gaborone. Dept. of Geology.
A. Gieske, E. Selaolo, and S. McMullan.
IN: Regionalization in Hydrology. IAHS Publication No. 191. International Association of Hydrological Sciences, Washington, DC. 1990. p 33-44, 8 fig, 1 tab, 8 ref.

Descriptors: *Aeration zone, *Botswana, *Chlorides, *Environmental tracers, *Groundwater recharge, *Isotope studies, *Soil water, *Solute transport, *Tracers, Groundwater movement, Infiltration capacity, Rainfall infiltration, Root zone, Tritium, Unsaturated flow.

Research has been done in sandy loam soils of southeastern Botswana over the past two years to gain an understanding of solute and isotope distributions as a function of depth below the surface in order to quantify moisture fluxes through the unsaturated zone. Preliminary analysis of 16 profiles in a small study area has shown that, in comparison with results obtained in similar semiarid environments, the chloride concentrations in southeastern Botswana are rather low. Chloride concentrations in general do not seem to increase in the root zone of the common Acacia tree species and most enrichment takes place near the surface. The analysis of samples taken after the rainy season of 1987-1988 with an above average rainfall of 850 mm indicates that the mobility of the chloride, tritium, and stable isotopes in the unsaturated zone is very high over short distances. Drainage lines may affect infiltration, soil moisture, and solute transport considerably and this effect may be enhanced by sudden heavy rains. The conclusion can be drawn that variability of surface, soil, and plant characteristics may lead to complex three-dimensional water and solute movement in the unsaturated zone. Calculation of recharge on the basis of chloride and isotope data along a single vertical profile seems inadvisable in the present case; one-dimensional steady-state infiltration models are not applicable. (See also W91-07920) (Fish-PTT)
W91-07925

SALINIZATION HAZARD IN A POLDER SOIL OF BELGIUM.
Ghent Rijksuniversiteit (Belgium). Faculteit Landbouwwetenschappen.
M. Van Meirvenne, R. Hartmann, M. De Boodt, and W. De Breuck.
IN: Proceedings of 10th Salt-Water Intrusion Meeting. Geologisch Instituut R.U.G. (S 8), Ghent. 1989. p 85-94, 7 fig, 3 tab, 19 ref.

Descriptors: *Belgium, *Polders, *Saline groundwater, *Saline soils, *Soil analysis, *Soil surveys, *Soil water, Aeration zone, Agricultural water, Chlorides, Conductivity, Evapotranspiration, Groundwater movement, Piezometers, Salt stress, Salt tolerance, Tensiometers.

Hydrogeological surveys carried out in the polder area of northeastern Flanders (Belgium), showed the presence of saline water at varying depths, some at shallow depths that could restrict agricultural use. An experimental field design was set up in 1986 in order to investigate the salt distribution and evolution of a soil with a shallow brackish groundwater and to evaluate the impact of salinization on agricultural exploitation. Mercury tensiometers and soil-moisture extractors were installed. A piezometer was used to measure the groundwater table and a pluviometer recorded rainfall. The tensiometers and pluviometer were recorded 6 days a week, the piezometer weekly, and the soil-moisture extractors were sampled every 2 weeks. The electrical conductivity (EC) of the soil-water samples was measured as well as the chlorine concentration. Despite very rainy periods, drainage throughout the entire unsaturated zone was found to occur only during 18 of the 207 days observed. A primarily upward water movement was measured in the biggest part of the unsaturated zone, indicating water losses by evapotranspiration. Salt distribution was found to be rather stable. An EC of 2000 microS/cm varied between a depth of 80 cm (beginning of April) and 60 cm (end of August). At the same time an EC of 8000 microS/cm was encountered between 110 and 95 cm. Nevertheless, a reduction of the nonsaline zone by 20 cm between April and August means a serious limitation of the agricultural use of this soil. Upward water movement was found to be the major cause of this increase in salt content. At the end of the growing season (October), the grass showed chlorosis and necrosis. Analyses of these leaves showed a Cl concentration of 1.69% (dry matter). Agricultural use of this soil is restricted to pasture. Winter cereals could be considered as an alternative (barley being less salt-sensitive than wheat), but beets and maize are expected to yield substantially less than optimal due to the saline groundwater. (See also W91-07947) (Author's abstract)
W91-07954

HYDROCHEMISTRY OF PORE WATER FROM FINE-GRAINED SEDIMENTS (CLAY, SILT, PEAT) IN THE SOUTHERN PART OF THE WESTERN BELGIAN COASTAL PLAIN: THE YSER PLAIN.
Ghent Rijksuniversiteit (Belgium). Lab. for Applied Geology and Hydrogeology.
L. Zeuwts, L. Lebbe, and W. De Breuck.
IN: Proceedings of 10th Salt-Water Intrusion Meeting. Geologisch Instituut R.U.G. (S 8), Ghent. 1989. p 95-106, 12 fig, 1 tab, 10 ref.

Descriptors: *Belgium, *Geophysical surveys, *Groundwater quality, *Interstitial water, *Resistivity, *Samplers, *Soil water, Borehole geophysics, Brackish water, Coastal aquifers, Dissolved solids, Freshwater, Sampling, Soil texture, Water chemistry.

In coastal areas, and certainly in the Belgian coastal plain, hydrochemical investigations are impeded by the presence of fine-grained sediments such as clay, silt, and peat. Resistivity measurements in boreholes have, until present, only been calibrated for sandy formations. The relationship between the resistivity and the pore-water quality in fine-grained sediments is not clear, and representative groundwater samples from these formations are difficult to obtain. A fast and effective method for obtaining groundwater samples from fine-grained sediments has been developed: the high pressure filtration technique. By means of a high pressure stainless steel squeezer, pore fluids from undisturbed ground samples are pressed and filtered into a disposable syringe which can be capped and stored for investigation. The method was applied to the Yser plain in the western Belgian coastal plain to illustrate the usefulness of the filter press technique. Profiles were created for freshwater percentage, total dissolved solids, pore water resistivities, and formation resistivities. It was found that brackish to very brackish water is still the dominant quality and infiltration of freshwater only appears in the sandy creek and at the edges of the valley. The pore water samples thus obtained were used to calibrate the borehole resistivity measurements in fine-grained formations. Groundwater quality varies between fresh (F-type) and brackish-salt (Bs-type), with seven main types: CaHCO3, CaMix, CaSO4, NaHCO3, NaMix, NaSO4, and NaCl. The results of the chemical analysis of the pore water samples have led to a better understanding of the chemical and physical processes influencing groundwater quality. (See also W91-07947) (Fish-PTT)
W91-07955

FLUID FLOW AND SOLUTE TRANSPORT PROCESSES IN UNSATURATED HETEROGENEOUS SOILS: PRELIMINARY NUMERICAL EXPERIMENTS.
Hawaii Univ. at Manoa, Honolulu. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W91-08042

DIELECTRIC METHOD FOR PREDICTION OF POROSITY OF SATURATED SOIL.
California Univ., Davis. Dept. of Civil Engineering.
K. Arulanandan.
Journal of Geotechnical Engineering (ASCE) JGENDZ, Vol. 117, No. 2, p 319-330, February 1990. 4 fig, 1 tab, 12 ref.

Descriptors: *Electrical properties, *Saturated soils, *Soil porosity, Conductance, Laboratory procedures, Particulate matter, Porous media, Soil properties.

The electromagnetic theory of Maxwell-Fricke for electrical conduction through heterogeneous media is extended to develop a theoretical relationship for fluid-saturated porous media, accounting for the orientation of particles, the porosity and the dielectric constants of the pore fluid, the solid phase and the mixture. Based on this relationship, it is shown that a knowledge of the dielectric constants of saturated soils in the horizontal and vertical directions at high frequencies around 50 MHz provides the necessary data for the evaluation of the porosity for most soils when the dielectric constants of the particle and the solution are known. The method provides a rapid means for laboratory evaluation of the porosity of any saturated soil. It may also be adopted to in-situ evaluations of the porosity of any saturated soil. (Author's abstract)
W91-08081

IRRIGATION FREQUENCY EFFECTS ON LEACHING OF CATIONS FROM GYPSUM AMENDED COASTAL PLAIN SURFACE SOILS.
Citrus Research and Education Center, Lake Alfred, FL.
For primary bibliographic entry see Field 3F.
W91-08121

FATE OF C14-CARBARYL IN SOILS AS A FUNCTION OF PH.
Bhabha Atomic Research Centre, Bombay (India). Nuclear Agriculture Div.
For primary bibliographic entry see Field 5B.
W91-08162

2H. Lakes

RECOVERY OF ACIDIFIED AND METAL-CONTAMINATED LAKES IN CANADA.
Toronto Univ. (Ontario). Inst. for Environmental Studies.
For primary bibliographic entry see Field 5G.
W91-07234

PALEOECOLOGICAL ANALYSIS OF LAKE ACIDIFICATION TRENDS IN NORTH AMERICA AND EUROPE USING DIATOMS AND CHRYSOPHYTES.
Indiana Univ. at Bloomington. Dept. of Biology.
For primary bibliographic entry see Field 5C.
W91-07235

PAST AND RECENT OCCURRENCES OF MALACOSTRACA GLACIAL RELICTS IN POLISH LAKES.
Marine Biology Center, Al. Wojska Polskiego 11/13, 80-277 Gdansk, Poland.
L. Zmudzinski.
Annales Zoologici Fennici AZOFAO, Vol. 27, No. 3, p 227-230, December 1990. 2 fig, 1 tab, 12 ref.

Descriptors: *Aquatic animals, *Crustaceans, *Lakes, *Limnology, *Poland, *Water pollution effects, Amphipods, Ecological distribution, Opossum-shrimp, Population density, Transparency, Water depth.

Malacostracan glacial species have been found in a total of 48 Polish lakes. All these lakes were inhabited by Pallasea quadrispinosa, 7 of them by Mysis relicta, and 2 by Pontoporeia affinis. At present, because of pollution of the water, the number of lakes inhabited by the first 2 species has decreased significantly, while P. affinis has completely disappeared from Poland. In the western part of Poland, which has the highest degree of air pollution, 2

cases of the vanishing of some of the above species has been observed in the 1980s. Mysis relicta and P. quadrispinosa prefer lakes with the highest transparency values, that is, lakes with the greatest maximum depth, the largest surface area, and consequently the greatest water volume. Pallasea quadrispinosa has disappeared from at least 13 lakes situated near suburbs of towns and cities and heavily polluted by municipal wastes. In all the Polish lakes investigated, M. relicta inhabits practically the entire profundal. In the cleanest lakes P. quadrispinosa is distributed from the deepest parts up to the lower littoral. As the environmental conditions get worse in deep waters, P. quadrispinosa gradually withdraws from the deeper parts, finally inhabiting only the sublittoral and lower parts of the littoral. (Doria-PTT)
W91-07371

RECENT DISTRIBUTION OF GLACIAL RELICT MALACOSTRACA IN THE LAKES OF MECKLENBURG.
Rostock Univ. (German D.R.). Sektion Wirtschaftswissenschaften.
J. Kohn, and A. Waterstraat.
Annales Zoologici Fennici AZOFAO, Vol. 27, No. 3, p 237-240, December 1990. 3 fig, 4 tab, 8 ref.

Descriptors: *Aquatic animals, *Crustaceans, *Eutrophication, *Germany, *Lakes, *Limnology, *Mecklenburg, *Water pollution effects, Amphipods, Ecological distribution, Fish, Lake restoration, Mollusks, Opossum-shrimp, Population density.

The recent distribution of Mysis relicta, Pallasea quadrispinosa, and Pontoporeia affinis was investigated and compared to distribution data from the 1920s. Pontoporeia affinis has not been found recently. Mysis relicta occurs frequently in only one lake, while at two other sites its presence is now questionable. Only P. quadrispinosa exhibits a distribution similar to that which it had 60 years ago, although its frequency is decreasing. The decrease in the range of all these species is caused by a decrease in the oxygen concentration in the profundal of the lakes following increasing eutrophication. The occurrence of glacial relict fish where the populations are autochthonous points to the incidence of glacial relict Malacostraca, and repopulation of lakes by fish and Malacostraca may be possible in the same manner. (Doria-PTT)
W91-07373

LONG-TERM STUDIES OF PROFUNDAL ZOOMACROBENTHOS IN SWEDEN'S GREAT LAKES: IMPLICATIONS OF BIOTIC INTERACTIONS.
National Swedish Environment Protection Board, Uppsala. Environmental Impact Assessment Dept.
R. K. Johnson, and T. Wiederholm.
Annales Zoologici Fennici AZOFAO, Vol. 27, No. 3, p 291-295, December 1990. 2 fig, 11 ref. Swedish Environmental Protection Agency Contract SNV 5313177-7.

Descriptors: *Animal populations, *Benthic fauna, *Lake ecology, *Limnology, *Macroinvertebrates, *Sweden, Amphipods, Animal behavior, Aquatic animals, Biomass, Correlation analysis, Crustaceans, Food habits, Lakes, Midges, Oligochaetes, Population density, Temporal variation, Time series analysis, Weather.

Time-series analysis of zoobenthos in Sweden's great lakes showed that the predominant macroinvertebrates seemed to exhibit long-term population trends. Though the causal mechanisms are not known, it is suggested that food availability and competitive interactions may be important factors. For example, Pontoporeia affinis density and biomass were significantly correlated (positively) with variables representing food quality and quantity. During years with high abundances of amphipods, interactions between the predominant zoobenthic components may be important structuring forces. Profundal populations of Oligochaeta and Pisidium spp. in Lake Vanern exhibited long-term oscillations 'in phase' with Pontoporeia. In contrast, the abundances of P. affinis and Chironomidae in Lake Malaren were 'out of phase' with each other. Differences in foraging behavior may be an important mechanism lowering encounter rates and exploitative interactions between coexisting populations. It is suggested that meteorological cycles may influence pelagic production and allochthonous inputs (food availability), and, with time-lags, affect zoobenthic populations. However, interactions between the predominant zoobenthic populations, such as competition for food (exploitative) and physical disturbance (interference), may be equally important in forming the long-term trends. (Author's abstract)
W91-07374

SHRIMP STOCKING, SALMON COLLAPSE, AND EAGLE DISPLACEMENT.
Montana Univ., Polson. Flathead Lake Biological Station.
For primary bibliographic entry see Field 6G.
W91-07381

VERTICAL DISTRIBUTION OF PELAGIC JUVENILE SOCKEYE SALMON (ONCORHYNCHUS NERKA) IN KURIL'SKOYE LAKE DURING THE SUMMER-FALL PERIOD.
Tikhookeanskii Nauchno-Issledovatel'skii Inst. Rybnogo Khozyaistva i Okeanografii, Petropavlovsk-Kamchatskii (USSR).
A. S. Nikolayev.
Journal of Ichthyology JITHAZ, Vol. 30, No. 3, p 109-124, 1990. 6 fig, 32 ref. Translated from Voprosy ikhtiologii, Vol. 30, No. 3, p 392-403, 1990.

Descriptors: *Ecological distribution, *Fish management, *Fish populations, *Limnology, *Salmon, Acoustics, Convection, Epilimnion, Fish, Juvenile growth stage, Kamchatka, Lakes, Seasonal variation, Surveys, Temperature, Thermal stratification, Thermocline, Upwelling, Vertical distribution.

Some aspects of vertical distribution of pelagic juvenile sockeye salmon in Kuril'skoye Lake in the summer-fall period as a function of wind direction and associated temperature and convection were studied based on data from integrated hydroacoustical surveys of actively feeding juveniles. During the summer and fall, juvenile salmon are distributed rather uniformly in the lake within the 0-55 m range. Vertical distribution of juveniles during daylight in summer and fall is characterized by a gregarious distribution type. Independent of season, juvenile schools are distributed in the 15-80 m layer with peak aggregation in the 20-65 m range. During the day, juveniles are distributed in the epilimnion and thermocline, and at night only in the epilimnion. In centers of wind-generated upwellings and other upward water movement, the upper boundary of the habitation zone sinks. Localization of aggregations of actively feeding salmon in the lake is associated with convergences that are often stirred up along the shore by passage of internal waves. Fertilization of Kamchatka sockeye salmon should be preceded by analysis of the limnological indicators and of the natural zones in which the lakes are found that determine productivity and vertical distribution of the fish. (Doria-PTT)
W91-07397

HYDROLOGIC REGIMES OF VARIOUS TYPES OF SPAWNING GROUNDS OF SOCKEYE SALMON, ONCORHYNCHUS NERKA.
Tikhookeanskii Nauchno-Issledovatel'skii Inst. Rybnogo Khozyaistva i Okeanografii, Petropavlovsk-Kamchatskii (USSR).
V. N. Bazarkin.
Journal of Ichthyology JITHAZ, Vol. 30, No. 3, p 31-39, 1990. 2 fig, 4 tab, 11 ref. Translated from Voprosy ikhtiologii, Vol. 30, No. 3, p 463-468, 1990.

Descriptors: *Fish management, *Fish populations, *Hydrological regime, *Salmon, *Spawning, Annual distribution, Creeks, Flow velocity, Hydrology, Incubation, Kamchatka, Lakes, Population dynamics, Reproduction, Rivers, Seasonal variation, Water currents, Water level, Water temperature.

Sockeye spawning grounds in lakes, rivers, and creeks in the Lake Azabach'ye drainage (Kamchatka) were investigated that differ in their hydrology, geomorphology, and hydrogeology. Various elements of the hydrologic regime that affect the reproduction of salmon were studied in the spawning grounds of 19 subisolates. The results are applicable to population ecology and acclimatization of salmon. The three types of spawning grounds are differentiated in absolute values and in the annual distribution of water levels, water temperatures in the substrate and at the surface, current velocities, and discharges. Current velocities vary between 0.7 and 0.2 m/s during the spawning period. There is a twofold reduction during the time of incubation. The seasonal variation of discharge is adequate to maintain current velocities. Water levels in the spawning grounds of the spring and summer sockeye differ by one order, their annual variation is uneven, and the differences from year to year are quite considerable. There is a pattern to the distribution of water temperatures in the substrate and in the bottom water layer in the spawning grounds, with seasonal variations that are not the same for the different types. Temperature differences from year to year in the same spawning grounds can be 25%. (Doria-PTT)
W91-07398

EFFECT OF SUBSTRATE COMPOSITION ON DETRITUS ACCUMULATION AND MACROINVERTEBRATE DISTRIBUTION IN A SOUTHERN NEVADA DESERT STREAM.
Nevada Univ., Las Vegas. Dept. of Biological Sciences.
M. S. Parker.
Southwestern Naturalist SWNAAB, Vol. 34, No. 2, p 181-187, 1989. 1 fig, 3 tab, 18 ref.

Descriptors: *Benthic fauna, *Deserts, *Detritus, *Ecological distribution, *Macroinvertebrates, *Stream biota, Biomass, Colonization, Correlation analysis, Food chains, Gravel, Mayflies, Midges, Nevada, Particle size, Population density, Species composition.

A 32-day colonization experiment was conducted to assess the effect of substrate particle size on the accumulation and size distribution of particulate detritus and on the distribution and abundance of benthic macroinvertebrates in a southern Nevada desert stream. The smallest substrate (gravel) collected the greatest quantity of fine detritus (<1 mm) and was colonized by the greatest number of macroinvertebrates. The largest substrate (cobble) collected the smallest quantity of fine detritus and the largest quantity of coarse detritus (>1 mm) and was colonized by the lowest number of macroinvertebrates. Although macroinvertebrate abundance was significantly higher in gravel substrate, macroinvertebrate biomass was greatest in the cobble substrate, indicating a difference in the size of organisms colonizing the different substrates. There was a significant positive correlation between macroinvertebrate biomass and detritus quantities. The benthic macroinvertebrate assemblage was dominated by small-bodied collector-gatherer insects, dominated by Baetis sp. (Ephemeroptera) and Orthocladiinae (Chironomidae), indicating the importance of this trophic group and their fine detrital food resource to the structure and function of desert stream ecosystems. (Author's abstract)
W91-07399

FISHES OF THE RIO DE LA CONCEPCION BASIN, SONORA, MEXICO, AND THE STATUS OF THE SONORA CHUB, GILA DITAENIA, A SPECIES IN DANGER OF EXTINCTION (LOS PECES DE LA CUENCA DEL RIO DE LA CONCEPCION, SONORA, MEXICO, Y EL ESTATUS DEL CHARALITO SONORESE, GILA DITAENIA, UNA ESPECIE EN AMENAZA DE EXTINCION).
Arizona Game and Fish Dept., Phoenix.
D. A. Hendrickson, and L. J. Romero.
Southwestern Naturalist SWNAAB, Vol. 34, No. 2, p 177-187, 1990. 1 fig, 3 tab, 10 ref. English summary.

Descriptors: *Chubs, *Endangered species, *Fish populations, *Mexico, Creeks, Ecological distribution, Fish management, Introduced species, Lentic environment, Lotic environment, Monitoring, River basins, Sampling, Sonora, Stream biota.

The Sonora chub, Gila ditaenia, was listed as threatened by the United States Fish and Wildlife Service in 1986. This species, endemic to the Rio de la Concepcion drainage, the major part of which is in Sonora, occurs in the United States only in Sycamore Creek near Nogales, Arizona. One of the motives for listing the species as threatened was uncertainty regarding its status, distribution, and abundance in Mexico. Use of timed electrofishing in 17 lotic sites and seining in 8 lentic habitats in Sonora revealed that the chub is widely distributed (16 of 17 lotic sites) and is the most abundant species in biomass and, frequently, in terms of numbers as well. Despite finding 7 exotic fish species, native fishes dominated stream collections throughout the basin (99.7% of total numbers; 96.9% of total biomass), while impoundments harbored totally exotic ichthyofaunas. Threatened status is appropriate for Sonora chub only if the peripheral and geographically isolated population in Arizona is considered; however, it is evident that the species in general is presently relatively secure. Recommended future management activities are periodic monitoring and taxonomic analysis directed at determining the relationship of the Arizona population to that of others and the extent of genetic introgression by the endangered Yaqui chub, Gila purpurea. (Author's abstract)
W91-07401

HYDROBIOLOGY OF SEBKHAS AND GUELTAS IN THE KHNIFISS-LA'YOUNE REGION.
Institut Scientifique, Rabat (Morocco). Dept. de Zoologie et Ecologie Animale.
M. Ramdani.
Trav. Inst. Sci. Rabat, Mem. Hors Serie, p 87-94, 1988. 3 fig, 4 tab, 9 ref.

Descriptors: *Aquatic animals, *Deserts, *Ecological distribution, *Intermittent lakes, *Morocco, Biogeography, Copepods, Crustaceans, Life cycles, Saline water, Sediments, Seed-shrimp, Springs, Vertical distribution, Wadi, Waterfleas.

The coastal platform in the Khnifiss region (Morocco) is divided by several deep dry river beds (oueds or wadis) and characterized by a number of sebkhas and gueltas. These intermittent inland water-bearing features are deep, flat-bottomed depressions not connected to the sea and their bottom elevation is often below sea level. Four sebkhas, two gueltas, and one spring were examined in order to identify the aquatic fauna of the Khnifiss region and to monitor its development over time. The reactivation by means of inundation of dormant forms buried in the sediments of sebkhas revealed the presence of crustaceans (copepods, cladocerans, and ostracods). Cladocera, Diaptomidae, and Ostracoda are usually distributed in the first 5 cm. Harpacticoid copepods are absent from the top 5 cm, rare between 5 and 10 cm, numerous between 10 and 25 cm, and absent between 25 and 50 cm. The seasonal development of the more diversified fauna was monitored in the areas under water during the study period (guelta and spring). The fauna of the Khnifiss zone is dominated by species typical of saline environments that have a wide geographical distribution. Other species, more typical of desert regions, were found at the southernmost limits of their range. (Doria-PTT)
W91-07412

MANAGED AQUATIC ECOSYSTEMS.
For primary bibliographic entry see Field 6A.
W91-07417

FRESH-WATER POND ECOSYSTEMS MANAGED UNDER A MODERATE EUROPEAN CLIMATE.
Instytut Rybactwa Srodladowego, Piaseczno (Poland). Zabieniec Centre.
For primary bibliographic entry see Field 8I.
W91-07420

MAN-MADE RESERVOIRS AS MANAGED ECOSYSTEMS IN TROPICAL AND SUB-TROPICAL INDIA.
Central Inland Capture Fisheries Research Inst., Barrackpore (India).
For primary bibliographic entry see Field 8I.
W91-07421

MANAGEMENT OF AUTOTROPHIC MASS CULTURES OF MICRO-ALGAE.
National Inst. for Water Research, Pretoria (South Africa).
D. F. Toerien, J. U. Grobbelaar, and R. D. Walmsley.
IN: Managed Aquatic Ecosystems. Ecosystems of the World, 29. Elsevier Science Publishing Co., New York. 1987. p 111-123. 5 fig, 101 ref.

Descriptors: *Algae, *Algae harvesting, *Aquaculture, *Culturing techniques, *Mathematical models, Autotrophic culture, Bacteria, Biomass, Biotransformation, Health food, Mass culture, Solar energy.

Algal mass cultivation technology varies from the extremely unsophisticated to the highly sophisticated. Mass cultivation systems are operated on defined or semi-defined media called clean cultures, or on wastes or effluents where the product contains not only algae, but also other organisms, notably bacteria, and is referred to as algal-bacterial biomass. The clean culture systems may further be subdivided according to their mode of growth as autotrophic (production by photosynthesis alone) mixotrophic (production by photosynthesis and heterotrophy) and heterotrophic modes (production by heterotrophy alone). A review of autotrophic clean culture systems which includes design of culture units, abiotic and biotic factors affecting productivity and mathematical models of productivity are presented. Although mathematical models cannot predict the invasion of a culture by other organisms, they are extremely helpful in delineating operational strategies and optimizing the design of systems. Management of autotrophic micro-algal mass cultures is not yet fully developed but the high productivity and other desirable characteristics of micro-algae still make them valuable for research and a potential source of proteins or other chemicals to man. (See also W91-07417) (Medina-PTT)
W91-07422

FORESTED WETLANDS.
Ecosystems of the World, 15. Elsevier Science Publishing Co., New York. 1990. 527p. Edited by Ariel E. Lugo, Mark Brinson, and Sandra Brown.

Descriptors: *Forests, *Marshes, *Swamps, *Wetland forests, *Wetlands, Databases, Fisheries, Floristic composition, Groundwater, Soils, Surface water, Unifying principles, Wildlife habitats.

Forested wetlands have important roles in global biogeochemical cycles, supporting fresh-water and salt-water commercial fisheries, and in providing a place for wildlife of all kinds to flourish. Scientific attention towards these ecosystems has lagged with only a few comprehensive works on forested wetlands of the world. A major emphasis of this book is to develop unifying principles and data bases on the structure and function of forested wetlands, in order to stimulate scientific study of them. Wetlands are areas that are inundated or saturated by surface-water or ground-water, at such a frequency and duration that under natural conditions they support organisms adapted to poorly aerated and/or saturated soil. The strategy of classifying the conditions that control the structure and behavior of forested wetlands by assuming that the physiognomy and floristic composition of the system will reflect the total energy expenditure of the ecosystem; and the structural and functional characteristics of forested wetlands from different parts of the world are the major topics covered. (See W91-07425 thru W91-07442) (Medina-PTT)
W91-07424

ENERGY THEORY OF LANDSCAPE FOR CLASSIFYING WETLANDS.
Eastern Michigan Univ., Ypsilanti. Dept. of Biology.
P. C. Kangas.
IN: Forested Wetlands. Ecosystems of the World, 15. Elsevier Science Publishing Co., New York. 1990. p 15-23. 3 fig, 2 tab, 35 ref.

Descriptors: *Ecosystems, *Swamps, *Wetland classification, *Wetland forests, *Wetlands, Acidity, Depressions, Energy sources, Groundwater, Hydrologic head, Kinetic energy, Nutrients, Physiognomy, Potential energy, Slopes, Surface water, Vegetation, Water currents, Water distribution.

Environmental energy sources determine ecosystem characteristics. The spatial distribution of energy is considered to determine the spatial form and distribution of ecosystems. The spatial expression of energy sources is then used as the distinguishing feature of a land classification scheme. This classification is applied here to forested wetlands, but is general and applies to all land surfaces. In classifying wetlands, the role of water as an energy source is obviously important. Different energy values have been assigned to water depending on its use in the system in question. Examples include potential energy as a chemical reactant or as elevated hydrologic head, and kinetic energy as velocity in currents. For the purpose of classifying wetlands, however, the absolute value of water in its different uses is not immediately as important as the form of its distribution. Different forms of distribution of water are hereon matched with different wetland forms. A variety of schemes has been used in the past to classify wetlands including source of nutrients and water, species composition, acidity, physiognomy, geomorphology, salinity, and hydroperiod. Of special relevance to the classification proposed here is the scheme of Novitzki. His classification deals with two features: surface vs. groundwater as the water source for wetlands, and slopes vs. depressions as geomorphic templates. The latter is related to the distinction made between frontal energies, usually generated on slopes, and sheet energies, usually generated on flatlands and concentrated in depressions. Within these features, characteristics such as hydroperiod, depression depth, and vegetation are utilized for refinements. (See also W91-07424) (Medina-PTT)
W91-07425

LONG-TERM DEVELOPMENT OF FORESTED WETLANDS.
Eastern Michigan Univ., Ypsilanti. Dept. of Biology.
P. C. Kangas.
IN: Forested Wetlands. Ecosystems of the World, 15. Elsevier Science Publishing Co., New York. 1990. p 25-51. 11 fig, 9 tab, 299 ref.

Descriptors: *Forests, *Geomorphology, *Reviews, *Swamps, *Wetland forests, *Wetlands, Ecosystems, Fauna, Geological aspects, Hydrogeology, Hydrologic regime, Management, Microbes, Sediments, Time constants, Turnover time, Vegetation, Wetland development.

Forested wetlands (swamps) exhibit the intimate manner in which living and non-living systems are coupled. A swamp is both an ecological system of forest vegetation, microbes, and animals, and a geological system of landform, sediments, and hydrologic regimes. The relationship between both ecological and geological aspects of wetland development and how they relate are considered. Concepts and models of wetland development are surveyed and reviewed. Highlights of this survey show that aspects of ecosystem and landform develop together in a wetland landscape. Development is shown as a production process with ecosystems and landforms as the storages of landscape. Both storages share the production process and influence its rate through feedback. Although this form of interaction between storages is indirect, ecosystems sometimes contribute directly to landform. In wetlands, where water is needed by both ecosystem and landform processes, this relationship takes the form of landforms orchestrating hydrology while ecosystems provide the fine-tuning. The important distinction between ecosystems and landforms is their time constants. Al-

though there is a symbiosis between geology and ecology of landscape, time periods often distinguish the two subsystems. Turnover of ecosystems is often much faster than turnover of landforms. The study and comparison of time periods for storages of landscape can then form the basis for land-use management and planning. (See also W91-07424) (Medina-PTT)
W91-07426

CONCEPTS IN WETLAND ECOLOGY.
Institute of Tropical Forestry, Rio Piedras, PR.
A. E. Lugo, S. Brown, and M. M. Brinson.
IN: Forested Wetlands. Ecosystems of the World, 15. Elsevier Science Publishing Co., New York. 1990. p 53-85. 17 fig, 6 tab, 218 ref.

Descriptors: *Reviews, *Swamps, *Wetland forests, *Wetlands, Biogeochemical cycles, Biomass, Carbon cycle, Ecosystems, Energy, Fauna, Fisheries, Flooding, Hydroperiod, Organic carbon, Peat, Plants, Soils, Stressors, Succession, Wetland ecology, Xeromorphism.

A short introduction to important concepts of wetland ecology is presented. These include a worldwide estimate of wetland areas which is about 3% of the land surface; global role in the carbon cycle, fisheries production, and biogeochemical cycles; organic carbon export which has higher rates of export than any other major biogeographic region of the world; animal life which constitute a small but important fraction of the total biomass in forested wetlands; large-scale reduction due to conversion to other uses; hydroperiod which is the single most important regulator in wetlands; the influence of water and its effects on its plants, animals, and soil; xeromorphism in wetland plants for water conservation; energy language to represent ecosystem structures and functions; the energy signature which is the sum of all incoming energy flows to an ecosystem and the pattern of their delivery; zonation and succession of species; wetlands on slopes in Puerto Rico which intercept the path of the tropical trade winds as they cool adiabatically after a long fetch over the Atlantic Ocean; wetland stressors which is any factor or situation that forces a system to mobilize its resources and spend increased amounts of energy to maintain homeostasis; wetland values; sediment and peat accumulation; definition of concepts dealing with organic matter dynamics; tolerance of trees to flooding; anaerobic processes and detritus processing; response of wetlands to stressors; peat loss rates, and the influence of forested wetlands on water and soils. (See also W91-07424) (Medina-PTT)
W91-07427

STRUCTURE AND DYNAMICS OF BASIN FORESTED WETLANDS IN NORTH AMERICA.
Illinois Univ. at Urbana-Champaign. Dept. of Forestry.
S. Brown.
IN: Forested Wetlands. Ecosystems of the World, 15. Elsevier Science Publishing Co., New York. 1990. p 171-199. 5 fig, 11 tab, 86 ref.

Descriptors: *Canada, *Florida, *Forests, *Mangrove swamps, *North America, *Reviews, *Swamps, *Wetland forests, *Wetlands, Basins, Cycling nutrients, Ecosystems, Energy, Evapotranspiration, Groundwater, Oil pollution, Organic matter, Precipitation, Sedimentation, Seeps, Thermal pollution, Vegetation.

Freshwater basin wetlands are found in depressions of various depths, generally in areas where precipitation exceeds evapotranspiration or where the depression intersects the water table creating groundwater seeps or springs. Forested basins are those that contain woody vegetation with the potential for reaching tree stature; they do not include woody shrub wetlands. In North America (USA and Canada) these areas are mainly in the central and eastern region. Pertinent information and reviews on the distribution, floristic composition, structure and dynamics of basin forested wetlands are summarized. The major emphasis is on freshwater wetlands, but data for saltwater wetlands (mangroves) mainly from Florida and tropical America are included. The external factors affecting basin wetlands or the important components of a wetland's energy signature are described as well as the distribution and floristic composition of representative basin wetlands. Sections on structural characteristics, organic matter dynamics, and nutrient cycling comprise the bulk of quantitative information. The effects of disturbances (stressors), both natural and human induced, with varying degrees of impact depending upon the intensity and on the part of the ecosystem to which the stressor is applied are evaluated. Examples of stressors in basin wetlands include water impoundment, water diversion, thermal stress from hot water, sedimentation, addition of toxic substances, addition of wastewater, oil spills, and harvesting. (See also W91-07424) (Medina-PTT)
W91-07430

GREAT DISMAL SWAMP: AN ILLUSTRATED CASE STUDY.
Geological Survey, Reston, VA.
V. Carter.
IN: Forested Wetlands. Ecosystems of the World, 15. Elsevier Science Publishing Co., New York. 1990. p 201-211. 17 fig, 11 ref.

Descriptors: *Great Dismal Swamp, *North Carolina, *Plant populations, *Remote sensing, *Swamps, *Virginia, *Wetland forests, *Wetlands, Anthropogenic disturbance, Ecosystems, Hydrology, Litter, Nutrients, Phytoplankton, Vegetation, Water quality, Wildlife habitats.

The Great Dismal Swamp is an 84,000 ha forested wetland on the Virginia-North Carolina border in the southern Atlantic Coastal Plain of the United States. The organic soils of the swamp range in depth from 4 m in ancient drainage channels to less than 0.3 m along the outer edges. Lake Drummond, approximately 4 km in diameter, is almost centrally located within the swamp. The flora includes individual species and plant assemblages otherwise scattered widely to the north and south along the Coastal Plain. Anthropogenic disturbance of the natural vegetation has resulted in a wide diversity of wildlife habitats. Present studies include the dynamics of the wetland-to-upland transition zone, wetland hydrology, litter production and nutrient studies in individual communities, water quality and phytoplankton populations in the lake and ditches, vegetation trends and regeneration strategies, organic soil development and wildlife habitat requirements. Remotely-sensed data provide an overview and level of detail needed to put small areas into perspective with the total ecosystem represented by this swamp. (See also W91-07424) (Medina-PTT)
W91-07431

ECOLOGY AND MANAGEMENT OF SWAMP FORESTS IN THE GUIANAS AND CARIBBEAN REGION.
P. R. Bacon.
IN: Forested Wetlands. Ecosystems of the World, 15. Elsevier Science Publishing Co., New York. 1990. p 213-250. 20 fig, 7 tab, 97 ref.

Descriptors: *Central America, *Forests, *Marshes, *South America, *Swamps, *Trinidad, *West Indies, *Wetland forests, *Wetlands, Fauna, Flooding, Literature review, Plant populations, Succession, Vegetation.

Wet forested ecosystems are a regular feature of the low-lying coastal areas commonly referred to as swamps in the West Indies, Central America and Northern South America. Two broad facies of freshwater forests have been reacognized in the region: (1) swamp forest, found in soils which are permanently inundated or have perennially high water table; and (2) marsh forest in areas subjected to periodic inundation. A literature review indicates several subdivisions of plant communities, giving the impression that these wetland communities differ significantly from one country to another. In most areas the swamp forests and marsh forests are associated with herbaceous swamp or marsh communities, introducing further complexity into successions. This study and review attempts to resolve some of the problems with the term swamp and marsh and some confusion regarding succession. Because of the inaccessibility of the Neotropical wetlands and the large number of plant species involved, there is still a dearth of description of the vegetation and its history. The vegetation has received more attention than the swamp animals with only a provisional checklist for the frewhwater wetland of one country (Trinidad) in the Caribbean and Guianas region. Exploitation is minimal and management is virtually nonexistent for swamp forests in Neotropical regions. (See also W91-07424) (Medina-PTT)
W91-07432

ECOLOGY OF PTEROCARPUS OFFICINALIS FORESTED WETLANDS IN PUERTO RICO.
Ponce Technological Univ. Coll., PR.
M. Alvarez-Lopez.
IN: Forested Wetlands. Ecosystems of the World, 15. Elsevier Science Publishing Co., New York. 1990. p 251-265. 7 fig, 6 tab, 21 ref.

Descriptors: *Puerto Rico, *Swamps, *Wetland forests, *Wetlands, Drought, Flooding, Forest ecosystems, Hydroperiod, Plant populations, Pterocarpus forests, Runoff, Saline soils, Salinity, Soil organic matter, Species composition.

For Puerto Rico the existence of Pterocarpus forests had been known since 1882, although it was not until very recently that their specific localities and areas have been determined. Most of the 15 forest locations are concentrated in the northeastern region. In the past, the mountainous region was covered by Pterocarpus trees or stands, but at present only those in the Luquillo Mountains remain. Differences in hydroperiod, coupled with the presence or absence of salinity appeared to influence forest structure. The montane riverine Pterocarpus forest had the tallest canopy height, greatest basal area and greatest number of species. Differences in complexity and structure between the coastal basin forests and the coastal riverine types were related mainly to differences in soil salinities and flooding, and less to nutrient-rich upland runoff. In Pterocarpus forests, the riverine types stored less organic matter in the soil, but more in root biomass. The storage of soil organic matter was higher in Pterocarpus forests than in surrounding terrestrial forests. It is suggested that Pterocarpus forests are climax systems developing under a tropical location where flooding occurs with periods of drought to allow for seedling establishment and with low soil salinities of 0 to 12%. (See also W91-07424) (Medina-PTT)
W91-07433

FORESTED WETLANDS OF MEXICO.
Universidad Nacional Autonoma de Mexico, Mexico City. Inst. de Biologia.
For primary bibliographic entry see Field 2L.
W91-07435

OLIGOTROPHIC FORESTED WETLANDS IN BORNEO.
Hamburg Univ. (Germany, F.R.). Inst. of World Forestry.
For primary bibliographic entry see Field 2L.
W91-07436

WOODED SWAMPS IN NEW GUINEA.
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Land Research.
K. Paijmans.
IN: Forested Wetlands. Ecosystems of the World, 15. Elsevier Science Publishing Co., New York. 1990. p 335-355. 12 fig, 2 tab, 18 ref.

Descriptors: *Flood plains, *Mangrove swamps, *New Guinea, *Swamps, *Wetland forests, *Wetlands, Agriculture, Climates, Drought, Estuaries, Excess rainfall, Flooding, Salinity, Silviculture, Soil types, Tides, Vegetation.

The island of New Guinea lies wholly within the tropics, between the Equator and just over 10

degrees S latitude. Extensive alluvial plains flank both sides of a central 2000 km mountain range. Generally heavy rainfall and its markedly uneven distribution over the year for much of the island cause major river floods, that periodically inundate thousands of square kilometers varying periods of the year. Swamps are maintained wherever land gradients and drainage outlets are insufficient to disperse the rain and run-on waters which become impounded at the foot of hills, between higher-lying, more rapidly aggrading riverine tracts, or behind beach ridges. Swamps are also present in very gently shelving estuaries where river water is banked up by the incoming ocean tide through a maze of creeks and channels. Differences in flooding regime and drainage conditions and, in some regions, seasonal drought stress have given rise to a variety of swamp-vegetation types. Woody freshwater swamp vegetation generally occupies relatively shallow swamps where the water table is at or near the surface at least for part of the year. In deep, permanent, stagnant swamps, and in riverine tracts subject to deep and prolonged seasonal flooding by fast-moving water, wooded swamp gives way to herbaceous and grass swamp. Mangroves, the characteristic vegetation of the tidal coastal zone, range from a low scrub to a tall forest, depending on tidal regime, salinity, climate, soil, and age of the stands. Many thousands of lowland dwellers have exploited the swamps for commercial, agricultural and silvicultural purposes and have been hampered only by difficulties in access. (See also W91-07424) (Medina-PTT)
W91-07437

FORESTED WETLANDS IN AUSTRALIA.
Queensland Univ., Brisbane (Australia). Dept. of Botany.
R. L. Specht.
IN: Forested Wetlands. Ecosystems of the World, 15. Elsevier Science Publishing Co., New York. 1990. p 387-406. 30 fig, 4 tab, 37 ref.

Descriptors: *Australia, *Swamps, *Wetland forests, *Wetlands, Arid climates, Crops, Fauna, Plants, Rainfall, Runoff, Semiarid climates, Trees, Water demand.

Australia, a continental mass 7.7 million sq km in area, has about two-thirds of its area classed as semi-arid to arid. The humid coastal coasts are drained by short, perennial streams which flow towards the coasts discharging almost all of the runoff into the oceans. Much of the stream flow over the rest of the Australian continent is intermittent or non-existent because of low and unreliable rainfall, high evaporation losses, and flat topography. The largest inland river system is the River Murray and its tributaries which drain about one-seventh of the continent. Along these drainage systems form swamps, floodplains, river banks and even seasonally-dry streambeds which are the habitats of a series of forested wetlands which extend from the most humid areas of Australia into the arid interior. The forested wetlands can be classed as true forests only in the wettest localities. The largest area of forested wetland is on the floodplain of the Murray River in the region bounded by Tucumwal, Echuca and Deniliquin, where over 60,000 ha of red river gum (Eucalyptus camaldulensis) forest is found. On a continent as arid as Australia, water becomes limiting for man, his beasts, his crops, and his industries. Because of this demand for water, wetland in all areas of the continent, from humid to arid regions, have been destroyed or at risk. In this review, pertinent ecological notes and biological data for the main tree species of Australian forested wetlands (two species of Casuarina, nine species of Eucalyptus and ten species of Melaleuca) are presented, and major ecological principles controlling the distribution, structure, and regeneration of forested wetlands in Australia are developed. Ecological factors that were examined are: (1) variation in structure within a climatic region; (2) soil fertility; (3) temperatute response; (4) water balance; (5) effects of fire; and (6) species regeneration. (See also W91-07424) (Medina-PTT)
W91-07439

FORESTED WETLANDS IN WESTERN EUROPE.
J. Wiegers.
IN: Forested Wetlands. Ecosystems of the World, 15. Elsevier Science Publishing Co., New York. 1990. p 407-436. 10 fig, 6 tab, 174 ref.

Descriptors: *Europe, *Swamps, *Wetland forests, *Wetlands, Belgium, Conservation, Denmark, Ecosystems, France, Germany, Ireland, Luxembourg, Mosses, Plant populations, Silviculture, The Netherlands, Trees, United Kingdom, Vegetation.

Ecological characteristics, species composition of plant communities, structure and ecology of peatland and riverine forests are presented for Ireland, United Kingdom, Denmark, The Netherlands, Belgium, Luxembourg, Germany, and the northern half of France. Highly automated draining and irrigation systems that can be used for developing forested wetlands to meet agricultural and silvicultural demands in populated areas like these countries of Western Europe have created an urgent need for protection and conservation programs. Normal development in these woods seems to suffer from the presence of the introduced North American tree species (Amelanchier laevis, Aronia prunifolia, and Prunus serotina) which grow vigorously and suppress the shrub and herb layer in many peatland forests, especially in the Netherlands. The acrocarpous moss Orthodontium lineare which was introduced from the British Isles in the first decade of the century, produces dense monospecific carpets and is replacing the rich vegetation on tree bases. Animals are rare in these woods. However, such ecosystems with poor species composition present exquisite research areas to study and understand the functioning of the whole ecosystem. (See also W91-07424) (Medina-PTT)
W91-07440

FORESTED WETLANDS OF POLAND.
Polish Academy of Sciences, Mikolajki. Inst. of Ecology.
A. J. Szczepanski.
IN: Forested Wetlands. Ecosystems of the World, 15. Elsevier Science Publishing Co., New York. 1990. p 437-446. 4 fig, 3 tab, 36 ref.

Descriptors: *Plant populations, *Poland, *Swamps, *Wetland forests, *Wetlands, Alder trees, Bogs, Cycling nutrients, Ecosystems, Fens, Flooding, Marshes, Pine trees, Reviews, Soil types, Succession, Vegetation, Willow trees.

Timber from forested wetlands of Poland have little economic value, thus very few ecosystem studies have been made on its forested wetlands except for phytosociological aspects. More than 27.5% of Poland is forested and about 5% of the country is covered with wetlands, but no more than 1.5 to 2.2% can be recognized as forested wetlands. Three main types are recognized: (1) Willow-shrub wetland: a stage in the development of alder or birch swamps from marshes and fens; (2) Alder swamps: the main type of forested wetland; (3) Pine swamps: found on mineral-poor raised bogs. There are many transition stages between these wetlands and adjacent vegetation where flooding is of shorter duration. Riverside willow thickets and woody fringes bordering water bodies and water-courses are also included. There are other forest types in moist places, and these are classified as associations. An example is the alder-ash or Alno-Padion association. These forests on river alluvia are flooded every year for a short period only. Thereafter, the water subsides to more than 50 cm below the soil surface for most of the year. Succession, soils, litter production, decomposition and nutrient cycling of these forests are reviewed. (See also W91-07424) (Medina-PTT)
W91-07441

SYNTHESIS AND SEARCH FOR PARADIGMS IN WETLAND ECOLOGY.
Institute of Tropical Forestry, Rio Piedras, PR.
A. E. Lugo, M. M. Brinson, and S. Brown.
IN: Forested Wetlands. Ecosystems of the World, 15. Elsevier Science Publishing Co., New York. 1990. p 447-460. 8 fig, 3 tab, 23 ref.

Descriptors: *Ecosystems, *Literature review, *Swamps, *Wetland forests, *Wetlands, Cypress swamps, Ecology, Forest management, Human use, Hydroperiod, Peat bogs.

Observations on the forested wetlands of over 50 countries by 16 contributors are presented. Extensive literature and many patterns of forested wetland response to environmental factors are reviewed. The bulk of information on forested wetlands from many parts of the world tends to be floristic, or it focuses on individual species or phenomena. Descriptions of ecosystem structure and dynamics, hydroperiod, and biogeochemistry are not abundant. Bruenig's work on the physiognomy of peat swamps and Myer's study of hydroperiod in Costa Rican palm swamps are exceptions. These kinds of data are critical for advancing the understanding of forested wetlands and for properly managing and assessing their role in the landscape. Fewer still are experimental approaches on these ecosystems. Paradigms of forested wetland ecology are reviewed, and patterns of ecosystem response which could be tested in the future are proposed. Reference is made to the work of Odum for an overview of what is known about cypress wetlands, including detailed discussions of diurnal, seasonal, and long-term patterns of ecosystem function, regional role of wetlands, wetland values, and human use. It is proposed that the principles of forested wetland ecology are the same as those for other wetland types. (See also W91-07424) (Medina-PTT)
W91-07442

CARBON DYNAMICS IN EUTROPHIC, TEMPERATE LAKES.
Elsevier Science Publishing Co., New York. 1986. 284p. Edited by Bo Riemann and Morten Sondergaard.

Descriptors: *Aquatic productivity, *Carbon cycle, *Eutrophic lakes, *Limnology, *Microorganisms, *Organic carbon, *Plankton, Aquatic bacteria, Biotransformation, Dynamics, Fish, Food chains, Lake ecology, Metabolism, Organic matter, Phytoplankton, Reviews, Temperate zone, Water chemistry, Zooplankton.

Papers dealing with pools, pathways, fluxes and transformation of organic matter in the pelagic zone of eutrophic, temperate, lakes are presented. The work was conducted by a Danish Natural Science Research Council temporary research group. Although priority was given to interactions between planktonic microorganisms and their surrounding environments, some attention was also paid to changes in biological structure and carbon pathways induced from higher tropic levels, e.g., by planktivorous fish. Dissolved organic carbon in lakes, phytoplankton, bacteria, zooplankton, and planktivorous fish are among the topics covered. In addition production and feeding rates, evaluation of methods and data, and interactions between organisms are also included fas well as a description of carbon metabolism and community regulation in eutrophic, temperate lakes, including the carbon budget in both low-productive and highly productive lakes. (See W91-07448 thru W91-07453) (VerNooy-PTT)
W91-07447

DISSOLVED ORGANIC CARBON (DOC) IN LAKES.
Kongelige Veterinaer- og Landbohoejskole, Copenhagen (Denmark). Inst. of Microbiology.
N. O. G. Jorgensen.
IN: Carbon Dynamics in Eutrophic, Temperate Lakes. Elsevier Science Publishing Co., New York. 1986. p 5-24. 3 fig, 2 tab, 9 ref.

Descriptors: *Carbon cycle, *Dissolved organic carbon, *Dissolved solids, *Eutrophic lakes, *Lake ecology, *Limnology, Aquatic bacteria, Biotransformation, Chemical composition, Humic substances, Organic compounds, Particulate matter, Photosynthesis, Phytoplankton, Primary productivity, Zooplankton.

The principal producers of organic matter in pelagic ecosystems are microscopic phytoplankton organisms. During their photosynthesis inorganic

carbon is reduced and organic carbon compounds are produced. Phytoplankton photosynthesis leads to production of both particulate organic matter (POM, the algae) and dissolved organic matter (DOM, the released compounds). The total amount of dissolved organic matter, determined as DOC, has been measured in a number of lakes of different primary productivities. Studies of composition of DOM and DOC have dealt both with different molecular-weight classes of the DOC, and with the identification of specific substances. Humic substances, certain polysaccharides and other refractive compounds may occur in fairly large amounts, while natural concentrations of labile DOC compounds, such as free saccharides, free amino acids and organic acids, are generally low. All aquatic organisms contribute dissolved organic matter to the ambient water. Products of release from phytoplankton include organic acids, nucleic acids and their derivatives, mono and disaccharides, carbohydrates, sugar alcohols, amino acids. peptides, proteins vitamins and lipids. Most compounds released by zooplankton, mainly cladocerans, appear to be organic nitrogen compounds, in particular amino acids and other primary amines although organic phosphorus compounds may also occur. DOC serves both as a carbon and energy source to heterotrophic bacteria, but the bacteria themselves can also produce dissolved organic compounds during their metabolism. In general, the exact sources of individual organic molecules cannot be determined in natural waters. Research results demonstrate that concentrations of specific organic compounds generally cannot be related to single biological events, but that several pools and processes must be considered to understand the dynamics of dissolved organic compounds. (See also W91-07447) (VerNooy-PTT)
W91-07448

PHYTOPLANKTON.
Aarhus Univ. (Denmark). Botanical Inst.
M. Sondergaard, and L. M. Jensen.
IN: Carbon Dynamics in Eutrophic, Temperate Lakes. Elsevier Science Publishing Co., New York. 1986. p 27-126. 38 fig, 7 tab, 252 ref.

Descriptors: *Biotransformation, *Carbon cycle, *Eutrophic lakes, *Limnology, *Organic carbon, *Phytoplankton, *Primary production, Data interpretation, Denmark, Dissolved organic carbon, Eutrophication, Laboratory methods, Reviews, Seasonal variation, Species composition, Surveys, Temperate zone, Zooplankton.

Carbon utilization in the phytoplankton community, primary production and methods to measure the flow of extracellular organic carbon (EOC) to bacteria and the fate of algal carbon upon death were studied. In the majority of eutrophic lakes lacking large littoral zones and in hypereutrophic lakes, the planktonic microalgae totally dominate the input of organic carbon. A survey of the phytoplankton in eutrophic, temperate lakes is given. The composition of the phytoplankton and its seasonal succession are discussed, and changes in composition caused by shifts in trophic status due to eutrophication processes or manipulation experiments, are demonstrated. Examples from Danish lakes are used extensively for illustration and a survey is given of the most important phytoplankton classes in eutrophic lakes, and their occurrence. Phytoplankton assimilation of dissolved inorganic carbon (DIC), its reduction to organic compounds and the build up of algal biomass are the origin of the carbon cycle. The two major routes from phytoplankton to other biological components are a direct utilization of particles by zooplankton grazing and the detrital pathway, which represents organic carbon transformed to DOC and utilized by bacteria for growth and maintenance energy. Current methods of investigating the algal release and bacterial utilization of EOC are presented, with emphasis on methodology, theoretical and practical assumptions, limitations and recent improvements. Due to its ease, the 14C-method has today become the most widely used way to measure primary production, although data interpretation is by no means easy. Topics presented include examples and controlling factors of extracellular release of EOC and the composition, decomposition of extracellular products and photoplankton lysis. (See also W91-07447) (VerNooy-PTT)
W91-07449

BACTERIA.
Copenhagen Univ., Hilleroed (Denmark). Det Ferskvands-Biologiske Lab.
B. Riemann, and M. Sondergaard.
IN: Carbon Dynamics in Eutrophic, Temperate Lakes. Elsevier Science Publishing Co., New York. 1986. p 127-197. 20 fig, 12 tab, 214 ref.

Descriptors: *Aquatic bacteria, *Bacterial metabolism, *Bacterial productivity, *Eutrophic lakes, *Limnology, *Secondary productivity, Biomass, Carbon cycle, Growth rates, Laboratory methods, Lake ecology, Organic carbon, Phytoplankton, Reviews.

Knowledge on the ecological importance of aquatic bacteria has increased dramatically during the last few years. A number of recent methodological improvements and new techniques have enabled the aquatic ecologist to estimate the bacterial secondary production in natural environments. Several methods to determine bacterial growth rates are discussed including 3H-thymidine incorporation into DNA; frequency of dividing cells (FDCX); sulfate uptake and incorporation into protein; dark fixation of carbon dioxide; increase in cell numbers, cell biomass or ATP; and 3H-adenine incorporation into DNA and RNA. A summary is made of bacterial production rates in eutrophic lakes, incorporating diel, vertical and seasonal changes. A discussion of bacterial assimilation of organic compounds incorporates a multi-concentration approach using Michaelis-Menten saturation kinetics as well as a single-substrate approach. Carbon from phytoplankton is a potential substrate capable of supporting bacterial production. It has been seen that rapid changes in the size of the bacterial biomass in natural populations may occur, and is caused by both macrozooplankton (Daphnia) and microheterotrophic flagellates. (See also W91-07447) (VerNooy-PTT)
W91-07450

ZOOPLANKTON.
Copenhagen Univ., Hilleroed (Denmark). Det Ferskvands-Biologiske Lab.
S. Bosselmann, and B. Riemann.
IN: Carbon Dynamics in Eutrophic, Temperate Lakes. Elsevier Science Publishing Co., New York. 1986. p 199-236. 11 fig, 4 tab, 131 ref.

Descriptors: *Carbon cycle, *Eutrophic lakes, *Grazing, *Lake ecology, *Limnology, *Zooplankton, Algae, Bacteria, Feeding rates, Particulate matter, Phytoplankton, Reviews, Seasonal variation, Species composition.

Natural populations of zooplankton in lakes comprise species ranging in size from a few microns up to several centimeters. Lack of suitable methods have made a close examination of the grazing on organic particulate matter difficult. The spatial heterogeneity and diel changes in grazing make the estimation of grazing of the zooplankton community extremely difficult. A list of the most abundant zooplankton species in eutrophic lakes will comprise few species of Crustacea and Rotifera. The feeding of zooplankton depends on various endogenous and environmental factors; feeding rates in natural plankton communities should be expressed by the ingestion rate regarding the zooplankton and by the grazing rate regarding the phytoplankton. Methods to determine zooplankton grazing include the use of 14C-labeled algae and bacteria as food. A table of the maximum ingestion rates of various species of Cladocera and Copepoda is given. A summary of the quantitative relationships between phytoplankton and zooplankton in lakes over all of the seasons is made in an attempt to understand the growth and grazing of natural zooplankton populations in eutrophic lakes. The lack of suitable methods to determine bacterial production influences the interpretation of results obtained from zooplankton grazing on natural bacterial assemblages. Considering the knowledge about the flux of organic matter from both phytoplankton and bacterial to zooplankton, an important question is the extent to which either of these potential food sources dominate the food for zooplankton in natural environments. (See also W91-07447) (VerNooy-PTT)
W91-07451

FISH COMMUNITY OF TEMPERATE EUTROPHIC LAKES.
Lund Univ. (Sweden). Limnological Inst.
L. Johansson, and L. Persson.
IN: Carbon Dynamics in Eutrophic, Temperate Lakes. Elsevier Science Publishing Co., New York. 1986. p 237-266. 11 fig, 6 tab, 119 ref.

Descriptors: *Eutrophic lakes, *Fish, *Fish food organisms, *Lake ecology, *Lake fisheries, *Limnology, Biomass, Carp, Eutrophication, Fish physiology, Perch, Reviews, Salmon, Temperate zone, Trophic level.

The number of studies on biomass, production and ingestion rates carried out on fish in eutrophic lakes are very low compared to studies on bacteria, phytoplankton and zooplankton. This paucity of studies makes it difficult to discuss general patterns at the fish level in lakes in terms of quantitative rates. In recent years, only two main approaches have been used to estimate the rate of food consumption in fishes; one based upon direct estimation of food consumption in the field; and one based on a combination of laboratory estimated metabolic demands and field data on growth, stomach contents and temperature. Eutrophication of lakes affects the fish community both with respect to changes in total biomass and species composition. The main change in species composition with a change from oligotrophic to mesotrophic conditions is the replacement of salmonids with percids as the most common group in the fish community. Effects of fish predation on the zooplankton community have been documented in a vast number of studies. In eutrophic lakes, these effects are more pronounced for cyprinid species than for other species, and effects on primary production and water chemistry have also been documented. The existence of these strong effects suggest that the interactions between different trophic levels are tightly interconnected and only by covering the whole trophic web including fish will it be possible to understand the dynamics of eutrophic lakes. (See also W91-07447) (VerNooy-PTT)
W91-07452

CARBON METABOLISM AND COMMUNITY REGULATION IN EUTROPHIC, TEMPERATE LAKES.
Copenhagen Univ., Hilleroed (Denmark). Det Ferskvands-Biologiske Lab.
B. Riemann, M. Sondergaard, L. Persson, and L. Johansson.
IN: Carbon Dynamics in Eutrophic, Temperate Lakes. Elsevier Science Publishing Co., New York. 1986. p 267-283. 6 fig, 3 ref.

Descriptors: *Aquatic productivity, *Carbon cycle, *Eutrophic lakes, *Lake ecology, *Limnology, *Metabolism, *Model studies, Dynamics, Environmental effects, Plankton, Temperate zone.

A synthesize of of the roles of phytoplankton, bacteria, zooplankton and fish in freshwater environments was conducted using two general carbon flow models. One model describes a moderately low-productive lake with phytoplankton productions of 60 g carbon/sq m/year; the other a productive lake with yearly phytoplankton production of 600 g carbon/sq m/year. The presentation of these two carbon budgets is used to illustrate changes in community carbon metabolism as a function of eutrophication. The models, presented as diagrams, includes five compartments of standing stock: phytoplankton, bacteria, microzooplankton, macrozooplankton and fish. Transport of carbon into and out of each compartment is indicated with arrows, with numbers indicating specific processes such as respiration, excretion, sedimentation and predation (grazing). Comparison between low and highly productive lakes assumes that such systems are at or close to equilibrium conditions. However, environmental factors such

as winter and summer kills may push the fish community away from equilibrium conditions and start a number of feedback mechanisms cascading down on lower trophic levels. Incorporating such factors into analysis will further increase understanding of the dynamics of freshwater systems. (See also W91-07447) (VerNooy-PTT)
W91-07453

ACID WATERS IN WALES.
For primary bibliographic entry see Field 5C.
W91-07472

CHEMICAL AND ECOLOGICAL EVIDENCE ON THE ACIDIFICATION OF WELSH LAKES AND RIVERS.
University Coll., Cardiff (Wales). School of Pure and Applied Biology.
S. J. Ormerod, and A. S. Gee.
IN: Acid Waters in Wales. Monographiae Biologicae Volume 66. Kluwer Academic Publishers, Norwell, Massachusetts. 1990. p 11-25. 8 fig, 1 tab, 33 ref.

Descriptors: *Acid rain effects, *Acidification, *Ecology, *Lake acidification, *Rivers, *Wales, Air pollution, Conifers, Diatoms, Fisheries, Forests, Land use, Moorlands, Reforestation, Surface water records, Water chemistry, Water quality.

The use of historical data on chemical and ecological change to describe trends in acidification in Wales is reviewed from four perspectives: (1) spatial comparisons between streams draining conifer and moorland; (2) historical data on water quality; (3) historical data on ecology; and (4) historical data on fisheries. It was found that unlike evidence from diatom studies, there are major problems in examining the evidence for acidification on the basis of historical data on chemistry, ecology or fisheries. Often such data are scarce or collected only on an 'ad hoc' basis which precludes a general assessment of long-term chemical or biological change at the Welsh regional level. Where data are available, difficulties of interpretation arise from changes in methods, study site or frequency of measurement. The causes of change are also difficult to identify since none of the available data have been collected for this purpose. Nevertheless, there are instances where ecological and chemical data are corroborative in indicating increased acidity over recent decades. Pronounced changes appear to have been in water catchments which contain conifer plantations, with evidence accumulated from pH records, acidification indices and declines among biological indicators. Such change is consistent with what probably has occurred since afforestation to create present-day differences between some moorland and forest streams. Such changes are also consistent with the acidification processes identified in afforested catchments. A measured decline in pH in moorland streams might also be consistent with acidification in systems independent of forest presence, as indicated by diatom studies, although the change in pH over recent decades was not greater than that expected by measurement error. (See also W91-07472) (Agostine-PTT)
W91-07473

RECENT ACIDIFICATION OF UPLAND LAKES IN NORTH WALES: PALAEOLIMNOLOGICAL EVIDENCE.
Minnesota Univ., Minneapolis. Limnological Research Center.
S. C. Fritz, A. M. Kreiser, P. G. Appleby, and R. W. Battarbee.
IN: Acid Waters in Wales. Monographiae Biologicae Volume 66. Kluwer Academic Publishers, Norwell, Massachusetts. 1990. p 27-37. 3 fig, 3 tab, 14 ref.

Descriptors: *Acid rain effects, *Acidification, *Air pollution, *Lake acidification, *Limnology, *Paleolimnology, *Pollution effects, *Wales, Case studies, Diatoms, Forests, Geochemistry, Hydrogen ion concentration, Moorlands, Paleoecology, Pollen, Reforestation, Sediment analysis, Watersheds.

Diatoms are sensitive indicators of various limnological conditions, and the distribution of many taxa is strongly related to lakewater pH or factors correlated with pH. Indices and predictive equations based on this relationship allow the quantitative reconstruction of past lakewater pH from diatom remains in lake sediments. The magnitude, timing, and causes of recent lake acidification in both moorland and afforested catchments in the Welsh uplands were evaluated. Diatom-based reconstruction techniques and Pb-210 dating were used to evaluate evidence for recent acidification of lakes and carbonaceous particles, magnetic and geochemical analyses were used to trace the depositional history of atmospheric pollutants at each site. Documentary records of catchment history and pollen and geochemical analyses of the lake sediments were used to evaluate whether any observed acidification can be correlated with changes in grazing pressure or burning in moorland catchments or with ploughing and forest growth in afforested lake catchments. Analyses have been completed from one afforested and six non-afforested lakes in mid and north Wales. Case studies are given of a moorland catchment and an afforested catchment. Results and similar palaeoecological analyses from other sites in north and mid Wales suggest extensive acidification of upland lakes has occurred since 1850. The onset of acidification has varied between sites from as early as 1850 to the mid-1940's. The pattern of acidification also varies greatly, with a rapid decline in pH at some sites and a more gradual decline at others. The magnitude of pH decline ranges from 0.5 to 1.5 units. This variability in the timing, rate, and magnitude of acidification clearly suggests that catchment characteristics play an important role in lake response to increased deposition of acid pollutants. (See also W91-07472) (Agostine-PTT)
W91-07474

ROLE OF ACIDITY IN THE ECOLOGY OF WELSH LAKES AND STREAMS.
University Coll., Cardiff (Wales). School of Pure and Applied Biology.
For primary bibliographic entry see Field 5C.
W91-07479

EFFECTS OF ACIDIFICATION ON FISH AND FISHERIES IN WALES.
NRA Welsh Region, Caernarfon.
For primary bibliographic entry see Field 5C.
W91-07480

ECOTOXICOLOGICAL STUDIES OF ACIDITY IN WELSH STREAMS.
University Coll., Cardiff (Wales). School of Pure and Applied Biology.
For primary bibliographic entry see Field 5C.
W91-07482

VEGETATION AND FLORA OF OPENED HYDROPHYTIC AREAS: DAMS AND STREAM SWAMPS IN THE CENTRE-EAST OF IVORY COAST (VEGETATION ET FLORE DE MILIEUX HYDROPHYTIQUE OUVERTS: BARRAGES ET BASFONDS DE RIVIERES, DU CENTRE-EST DE LA COTE-D'IVOIRE).
Universite Nationale de Cote d'Ivoire, Abidjan. Lab. de Botanique.
For primary bibliographic entry see Field 6G.
W91-07527

CHANGE OF WATER ENVIRONMENT IN YANGZHUOYONG LAKE, TIBET (IN CHINESE).
Sichuan Research and Monitoring Inst. of Environmental Protection, Chengdu (China).
For primary bibliographic entry see Field 6G.
W91-07536

INVESTIGATION ON SILT SOURCE OF POYANG LAKE AND RECENT SEDIMENT REGULARITY OF THE LAKE BASIN (IN CHINESE).
Hydrometerological Experiment Station of Poyang Lake, Xingzi (China).
D. G. Xiong.
Oceanologia et Limnologia Sinica (Hai Yang Yu Hu Chao) HYHCAG, Vol. 21, No. 4, p 285-292, 1990, 1 fig, 6 tab, 3 ref. English summary.

Descriptors: *Deposition, *Lake sediments, *Poyang Lake, *Sediment sources, *Sediment transport, *Sedimentation, *Silting, China, Lake basins, Lake morphometry, Sediment erosion, Sediment load, Sedimentation rates.

The sediment deposited in Poyang Lake, China, comes from five rivers: the Ganjiang, Fuhe, Xinjiang, Raohe and the Xiushui. The lake basin has an area of 464,664 sq km. The mean annual load of suspended sediment is 20,095,000 tons and the mean annual accumulation of sediment is 11,317,000 tons. The rate of deposition is 1.6 mm/year for the entire basin and 1.7 mm/year for the sediment contour line. Most of the deposition occurs from April to October. Periods of erosion occur from November to March. June has the maximum deposition of 4,759,000 tons. The largest deposits are located between 13 and 16 m above sea level and contain 63.7% of the deposited material. The sediment deposits in Poyang Lake will tend to increase, since the water level of its outlet, the middle and lower Changjiang (Yangtze) River, is gradually rising. (Author's abstract)
W91-07539

EMERGENCE OF STONEFLIES (PLECOPTERA) FROM THE ROSEAU RIVER, MANITOBA.
Department of Fisheries and Oceans, Winnipeg (Manitoba). Freshwater Inst.
For primary bibliographic entry see Field 2E.
W91-07550

INFLUENCE OF A FLOOD EVENT ON PHYTOPLANKTON SUCCESSION.
Zurich Univ., Kilchberg (Swizerland). Hydrobiological-Limnological Station.
F. Elber, and F. Schanz.
Aquatic Sciences AQSCEA, Vol. 52, No. 4, p 330-344, 1990. 8 fig, 1 tab, 51 ref.

Descriptors: *Floods, *Lake ecology, *Limnology, *Phytoplankton, *Population dynamics, *Switzerland, Flagellates, Lake Lucerne, River Reuss, Seasonal variation, Species composition, Succession, Urnersee.

The effect of the August 1987 River Reuss flood event on the phytoplankton biocoenosis in Lake Uri (Urnersee, part of Lake Lucerne, Switzerland) was investigated first by comparing biological, chemical and physical data sampled before the event with equivalent data sampled after the event; and second by comparing the phytoplankton succession in 1987 with that occurring in the flood-free year of 1989. As a result of the flood, there were changes in the physical and chemical environment of the phytoplankton which altered the composition of the phytoplankton community. The phytoplankton community existing before the flood, which was dominated by the slow growing species Tabellaria fenestrata, was replaced by a biocoenosis characterized mainly by various fast-growing species of flagellates, which represent a typical spring successional stage. After the flood, the return to stable physical and chemical conditions was followed by the reestablishment of the successional stage which had existed before the flood (termed reversion). (Author's abstract)
W91-07554

EFFECT OF LIGHT ON THE RELEASE OF ORGANIC COMPOUNDS BY THE CYANOBACTERIUM OSCILLATORIA RUBESCENS.
Institut National de la Recherche Agronomique, Thonon-les-Bains (France). Station d'Hydrobiologie Lacustre.
M. Feuillade, J. Feuillade, and V. Fiala.
Aquatic Sciences AQSCEA, Vol. 52, No. 4, p 345-359, 1990. 5 fig, 3 tab, 39 ref.

Descriptors: *Algal physiology, *Cyanophyta, *Dissolved organic carbon, *Light effects, *Lim-

nology, *Oscillatoria, *Photosynthesis, *Water chemistry, Amino acids, Carbon radioisotopes, Electrophoresis, Glucose, Liquid chromatography, Thin layer chromatography.

The effect of light intensity on the release of dissolved organic carbon during photosynthesis on carbon-14 sodium bicarbonate was investigated using the phytoplanktonic cyanobacterium Oscillatoria rubescens. The released products were fractionated by molecular size and chemical identifications attempted using combined thin-layer electrophoresis and chromatography, and high pressure liquid chromatography. Light had little effect on the quantity and composition of the released products when subjected to irradiances within the range of 6-60 micromoles/sq m/sec. However, the upper range inhibited photosynthesis of O. rubescens. The released carbon was always lower than 3% of the incorporated carbon, and mainly composed (62-86%) by small molecular weight compounds. The prevailing identified compounds were amino acids which represented more than 20% of the recovered radioactivity. Glucose was the only identified sugar. (Author's abstract)
W91-07555

CHANGES IN THERMAL STRUCTURE OF MODERATE TO LARGE SIZED LAKES IN RESPONSE TO CHANGES IN AIR TEMPERATURE.
Western Australia Univ., Nedlands. Centre for Water Research.
D. M. Robertson, and R. A. Ragotzkie.
Aquatic Sciences AQSCEA, Vol. 52, No. 4, p 360-380, 1990. 7 fig, 2 tab, 36 ref. NSF Long-Term Ecological Research Program, Contract BSR 85114330.

Descriptors: *Air temperature, *Climatic changes, *Greenhouse effect, *Lake Mendota, *Lakes, *Limnology, *Temperature effects, *Thermal stratification, *Water temperature, *Wisconsin, Epilimnion, Global warming, Hypolimnion, Mathematical models, Statistical models, Thermocline.

Interannual variability in the thermal structure of lakes is driven by interannual differences in meteorological conditions. Dynamic or mechanistic models and empirical or statistical methods have been used to integrate the physical processes in lakes enabling the response of the thermal structure to changes in air temperature to be determined. Water temperature records of Lake Mendota, Wisconsin, are possibly the most extensive for any dimictic lake in the world and allowed both approaches to be used. Results from both techniques suggest the mixed layer temperature increases with increasing air temperature. Results from the empirical approach suggested epilimnion temperatures increase 0.5 to 1.0 C per 1.0 C increase in air temperature compared to 0.4 to 0.85 C estimated from a dynamical model (DYRESM). Increased air temperatures are related to significant warming in deep water temperatures in the absence of stratification; however, mid summer hypolimnion temperatures are expected to change very little or increase only slightly in response to climatic warming. Both approaches suggest increases in air temperatures increase the length of summer stratification; results from the dynamic model suggest an increase of approximately 5 days per 1 C increase in air temperature. Longer stratification is reflected in shallower late summer thermocline depths. With these quantitative relationships and forecast increases in air temperature for the 2 x CO2 climatic scenario (Greenhouse Effect) from three General Circulation Models, projections are made describing the changes in the future mean thermal structure of moderate to large sized lakes. (Author's abstract)
W91-07556

VERTICAL EXCHANGE DUE TO HORIZONTAL DENSITY GRADIENTS IN LAKES; THE CASE OF LAKE LUCERNE.
Eidgenoessische Technische Hochschule, Zurich (Switzerland). Inst. fuer Mikrobiologisches.
D. C. van Senden, R. Portielje, A. Borer, H. Ambuhl, and D. M. Imboden.
Aquatic Sciences AQSCEA, Vol. 52, No. 4, p 381-398, 1990. 8 fig, 5 tab, 14 ref. Swiss NSF Grant 20-5429.87.

Descriptors: *Density currents, *Lake Lucerne, *Limnology, *Mixing, *Switzerland, *Water quality, Conductivity, Exchange flow, Hypolimnion, Oxygen requirements, Temperature.

Recent field investigations showed that differential mixing causes a significant density driven exchange between the two eastern basins of Lake Lucerne, Gersauersee and Urnersee, Switzerland. The long term vertical mixing characteristics during the winter mixing period and the influence of the resulting exchange flow on water quality were examined through the analysis of 10 years (1964-1974) of monthly limnological data. Vertical homogenization of the state variables (temperature, electric conductivity and density) averaged once every two years in Urnersee, but not once in Gersauersee where the ten year average winter mixed-layer depth extended to 120 m. In Urnersee, intense mixing was evident over the whole water column for every year. In contrast, intense mixing in the deeper layers of Gersauersee occurred approximately once every four years. A three-layer model showed that the electric conductivity at reference temperature 20 C signature of the Gersauersee intermediate water correlates best with the Urnersee deep water confirming the regular occurrence of a density driven exchange. For the lower layers, the oxygen consumption rate in Urnersee was approximately twice that for Gersauersee. It appears the exchange flow can act either as a source or sink for the oxygen balance of Urnersee deep water. The larger rate in Urnersee hypolimnion might also be associated with the larger sediment input to this system. Density driven exchange resulting from differential mixing is probably an important contribution to the vertical water replenishment in many lakes. (Author's abstract)
W91-07557

UNIONIDAE OF THE CHAGRIN RIVER: THE REMNANT OF A MOLLUSCAN FAUNA.
Ohio Dept. of Natural Resources, Columbus. Div. of Natural Areas and Preserves.
For primary bibliographic entry see Field 2E.
W91-07572

PHYTOPLANKTON SUCCESSION DURING ACIDIFICATION WITH AND WITHOUT INCREASING ALUMINUM LEVELS.
Kent State Univ., OH. Dept. of Biological Sciences.
For primary bibliographic entry see Field 5C.
W91-07660

WETLANDS: MITIGATING AND REGULATING DEVELOPMENT IMPACTS.
Urban Land Inst., Washington, DC.
For primary bibliographic entry see Field 2L.
W91-07807

1984 FLOODING OF MALHEUR-HARNEY LAKE, HARNEY COUNTY, SOUTHEASTERN OREGON.
Geological Survey, Portland, OR. Water Resources Div.
L. L. Hubbard.
Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4111, 1989. 1p, 4 fig, 2 tab, 1 map, 4 ref.

Descriptors: *Flooding, *Lakes, *Malheur-Harney Lake, *Maps, *Oregon, Evaporation, Groundwater movement, Hydrologic maps, Lake evaporation, Lake morphology, Precipitation, Rainfall-runoff relationships.

Malheur, Mud, and Harney Lakes are in the largest closed basin in Oregon (about 5,300 sq mi). The basin is in the north-central part of Harney County in southeastern Oregon. Total precipitation for the 7-yr period 1978-1984 was 150% of normal and record-high runoff occurred during the 3-yr period 1982-84. This record-high runoff in inflow streams resulted in extensive enlargement and joining of Malheur, Mud, and Harney Lakes, forming a large single body of water that is referred to as Malheur-Harney Lakes. On June 27, 1984, Malheur-Harney Lake reached a lake-surface elevation of 4,102.4 ft above sea level, the highest level in recorded history (1903-84), and covered an area of 170,000 acres (266 sq mi). Water enters the Malheur-Harney Lake from streams, from groundwater springs and seeps, and from precipitation falling directly on the lake surface. There is no surface outflow from the flooded lake. The only means by which water can leave the system is through evaporation. The estimated groundwater inflow to the lake was 120,000 acre-ft for the 1984 water year, but this calculation provides only a gross estimate of net 1984 water year groundwater inflow because it included all the estimation errors of the other variables in the water budget equation. The 30-yr, 19511-80, average annual precipitation for Malheur Refuge Headquarters is 9.07 inches. This average was greatly exceeded each year for the period 1978-84. The inflow from direct precipitation was 170,000 acre-ft for the 1984 water year. The Malheur Refuge Headquarters evaporation pan at Malheur Lake was not operated in 1984, but evaporation pan data were available from the Malheur Branch basin. The average ratio of the values for evaporation from the Malheur Refuge Headquarters pan to the Malheur Branch Experiment Station pan was 0.9. Estimated monthly evaporation was multiplied by the average area of the flooded lake surface for each month and totaled to determine the 1984 annual evaporation from the lake surface. Estimated evaporation from the Harney-Malheur lake surface was 520,000 acre-ft during 1984. The inundated areas shown on this map were determined by field inspections and by aerial photographs of the shoreline made while the lake was at an elevation of 4,102.4 ft. (Lantz-PTT)
W91-07811

POREWATER ACID/BASE CHEMISTRY IN NEAR-SHORE REGIONS OF AN ACIDIC LAKE: THE INFLUENCE OF GROUNDWATER INPUTS.
Old Dominion Univ., Norfolk, VA. Dept. of Civil Engineering.
G. C. Schafran, and C. T. Driscoll.
Biogeochemistry BIOGEP, Vol. 11, No. 2, p 131-150, November 1990. 8 fig, 1 tab, 45 ref.

Descriptors: *Acid lakes, *Acid rain, *Acidification, *Alkalinity, *Interstitial water, *Lake sediments, *Limnology, *Water chemistry, Aluminum, Aquatic life, Chemical analysis, Chemical interactions, Groundwater, Groundwater movement, Hydrogen ion concentration, Lakes, Seepage.

Sediment porewaters in the near-shore region (i.e., within 1 m of the shoreline) of an acidic lake (Dart's Lake, NY) were monitored during the summer of 1983 to investigate whether spatial variations in porewater acid/base chemistry were significant in this region of the lake. Results revealed that the near-shore sediment pore waters of Dart's Lake were substantially more variable than was previously observed in sediment porewaters in deeper parts of the lake (> 2m depth). Inputs of groundwater appeared to be responsible for much of this variability, particularly with regard to pore water redox conditions. Acidic porewater solutions with elevated levels of Al had not been previously observed in deeper water sediment pore waters of the lake, but were observed in some of the near-shore sites. Movement of elevated concentrations of H(+) and Al into the lake from these sediments appeared likely under the conditions observed in this study and would result in lake water alkalinity consumption. The occurrence of this acidic, Al-rich groundwater inputs could influence fish spawning, the distribution of near-shore sediment dwelling and epipelagic organisms, as well as the distribution of aquatic vegetation. (Korn-PTT)
W91-07836

OBSERVATIONS ON THE VEGETATION OF SOME SHALLOW LAKES NEAR THE MOUTH OF THE RIO YPANE, PARAGUAY (VEGETA-

TIONSKUNDLICHE BEOBACHTUNGEN AN FLACHWASSERSEEN NAHE DER MUNDUNG DES RIO YPANE, PARAGUAY).
Kiel Univ. (Germany, F.R.). Botanisches Inst.
A. Wolf.
Amazoniana AMAZAP, Vol. 11, No. 2, p 167-184, July 1990. 6 fig, 1 tab, 31 ref. English summary.

Descriptors: *Floating plants, *Limnology, *Littoral environment, *Paraguay, *Ypane River, Cattle, Flood plains, Oxbow lakes, Trees, Tropical regions, Vegetation.

Transects were established to study the floating and littoral vegetation of some shallow lakes near the mouth of the Rio Ypane (Paraguay). The first study location represents the initial stages of a 'floating meadow' (embalsado) on a small, nutrient-rich lake. Within the lake is a small, low island topped by a thick stand of Polygonum hydropiperoides. Two other sites are embalsados, probably of different origin, on a 'fossil' floodplain generated by the Rio Ypane. One is partially bordered by trees and has floating vegetation dominated by Salvinia auriculata. Zonation in the other embalsado is obscured by the intermingling of free-floating plants. Zonation was also studied on the margin of one of the oxbow lakes along the Rio Ypane. On the banks are zones of Hydrocotyle ranunculoides, Rhynchospora corymbosa, and Cyperus giganteus. Pistia stratiotes and other floating vegetation is very thick near the banks. Cattle graze on the western banks. These communities, especially the grazed margins along the lakes, seem to be widespread in the subtropical region of South America. (Doria-PTT)
W91-07852

SPATIO-TEMPORAL VARIATIONS IN THE ABUNDANCE AND PRODUCTIVITY OF BACTERIOPLANKTON IN A HUMIC LAKE ON THE CANADIAN SHIELD (VARIATIONS SPATIO-TEMPORELLES DE L'ABONDANCE ET DE LA PRODUCTION DU BACTERIOPLANCTON DANS UN LAC HUMIQUE DU BOUCLIER CANADIEN).
Montreal Univ. (Quebec). Dept. of Biological Sciences.
Y. Letarte, and B. Pinel-Alloul.
Canadian Journal of Microbiology CJMIAZ, Vol. 37, No. 1, p 64-73, January 1991. 6 fig, 4 tab, 88 ref. English summary.

Descriptors: *Bacterial productivity, *Bacterioplankton, *Canadian Shield, *Lake ecology, *Limnology, *Physiological ecology, Bacteria, Chlorophyll a, Correlation analysis, Ecological distribution, Epilimnion, Growth, Lakes, Phytoplankton, Population density, Primary productivity, Sampling, Seasonal variation, Spatial distribution, Temporal distribution.

The diel and summer variation of bacterioplankton production (estimated from H3-thymidine incorporation) and abundance (direct count with 4',6-diamidino-2-phenylindole staining) were followed at four depths in a Canadian Shield humic lake. Production was found to be highest and most variable in the epilimnion, but the differences between production estimates made at different times were statistically significant in only 5 out of 16 cases. Production differed significantly among depths in 14 out of 18 trials. The renewal time of the bacterial community varied between 1 and 20 days. Bacterioplankton production and primary production were uncorrelated, but bacterial production and chlorophyll a concentration were positively correlated. Small cocci represented between 52% and 80% of the bacterial cells in all samples. There was no correspondence between bacterial production and frequency of dividing cells. Bacterial production and abundance varied inversely throughout the season, bacteria being two to three times less concentrated in the spring, whereas production was two to three times higher. No correlation was found between bacterioplankton production and abundance. These results demonstrate the importance of small-scale sampling and the difficulty with which bacterioplankton production, its spatio-temporal variations, and the relationships between bacteria and phytoplankton can be predicted. (Author's abstract)
W91-07854

MODELLING PHOTOSYNTHETIC OXYGEN PRODUCTION IN RIVERS.
Florence Univ. (Italy). Dept. of Systems and Computer Science.
S. Marsili-Libelli.
Environmental Technology (Letters) ETLEDB, Vol. 12, No. 1, p 59-67, 1991. 5 fig, 2 tab, 12 ref.

Descriptors: *Arno River, *Model studies, *Oxygen balance, *Photosynthesis, *Phytoplankton, *Rivers, Algae, Biodegradation, Dissolved oxygen, Diurnal variation, Model testing, Population density, Seasonal variation, Sensitivity analysis, Solar radiation, Trophic level, Turbidity, Water pollution.

In nutrient-rich rivers, phytoplankton can contribute significantly to the dissolved oxygen balance in the summer when the algal population and solar radiation are at their highest. A simple model is proposed to describe the daily oxygen production by algae and to validate its parameters against experimental data taken from the river Arno, in Italy. Given the lack of experimental radiation data, a synthetic solar radiation profile was generated using astronomical calculus. The study was motivated by the observed diurnal fluctuation of the dissolved oxygen, which the model explains to a satisfactory degree. Unfortunately, more detailed data, specifically on organic pollution, turbidity, solar radiation, and algal density, were not available; hence, the loss term could not be further structured separating algal respiration and pollutant degradation. However, the observed diurnal pattern was well explained by the model at both the upstream and downstream locations along the river. A sensitivity study of the calibrated parameters was consistent with the river conditions at both locations. This model can easily be incorporated in more general water quality schemes where other contributions to the dissolved oxygen budget are taken into account. (Doria-PTT)
W91-07858

SEASONAL CHANGES IN SPECIES COMPOSITION AND PRODUCTION OF PERIPHYTON IN AN URBAN RIVER RUNNING THROUGH AN ABANDONED COPPER MINING REGION.
National Inst. for Environmental Studies, Tsukuba (Japan).
N. Takamura, S. Hatakeyama, and Y. Sugaya.
Japanese Journal of Limnology RIZAAU, Vol. 51, No. 4, p 225-235, October 1990. 7 fig, 4 tab, 24 ref.

Descriptors: *Heavy metals, *Miyata River, *Periphyton, *Productivity, *Rivers, *Urban areas, *Water pollution effects, Algae, Ammonium, Aquatic insects, Biomass, Chlorophyll a, Chlorophyta, Cyanophyta, Diatoms, Dissolved organic carbon, Japan, Light effects, Nitrates, Nitrogen, Phosphorus, Photosynthesis, Physiological ecology, Species composition, Water temperature, Zinc.

Seasonal changes in species composition and photosynthesis of the periphyton community were investigated in an urban river (River Miyata, Japan) polluted by copper (0.07-0.22 mg/L) and zinc (0.13-0.55 mg/L). The pH, water temperature, concentrations of dissolved organic carbon, dissolved inorganic nitrogen, soluble reactive phosphorus (SRP), total copper, and total zinc were measured. SRP was mostly below 0.01 mg/L, whereas ammonium-nitrate and nitrate-nitrogen were high, ranging from 0.1-2.0 mg/L and 0.9-4.0 mg/L, respectively. The number of species in the river was restricted (only 7-10). The dominant species were Chamaesiphon subglobosus, Phormidium foveolarum, P. uncinatum, Achnanthes minutissima, Nitzschia palea, Stigeoclonium aestivale, and Oocystis lacustris. The diatoms tended to be abundant with a lower temperature and Stigeoclonium tended to be dominant under better illuminated conditions. The maximum photosynthetic rates were related closely to water temperature, and values (0.0025-0.217 gC/gC/h) were lower than those for unpolluted rivers in the literature. However, chlorophyll a in the periphyton was high, ranging from 31 to 1,162 mg/sq m. Therefore, the primary production in this river was not low compared to unpolluted rivers. The unbalanced high algal biomass in contrast to low SRP concentrations may be due to low grazing pressures by the poorly developed aquatic insect community. (Author's abstract)
W91-07868

EXPERIMENTAL EXAMINATION ON NITROUS OXIDE ACCUMULATION DURING NITRIFICATION IN A FRESHWATER LAKE.
Nagoya Univ. (Japan). Water Research Inst.
M. Yoh.
Japanese Journal of Limnology RIZAAU, Vol. 51, No. 4, p 237-248, October 1990. 6 fig, 3 tab, 28 ref.

Descriptors: *Lakes, *Nitrification, *Nitrogen oxides, *Water chemistry, Ammonium, Incubation, Japan, Lake Kizaki, Limnology, Nitrates, Oxygen requirements.

Production of N2O during nitrification was studied in Lake Kizaki (Japan) by vertical observation and two incubation experiments. The apparent N2O production (the difference between observed and atmospheric-equilibrium concentration) was highly correlated with apparent oxygen consumption, in situ nitrate concentration, and the extent of ammonium ion decrease with time, indicating that N2O was produced by nitrification. In a long-term in situ incubation, simultaneous accumulations of nitrate and N2O were observed, the amounts of which were comparable to the in situ changes, suggesting their in situ production. Both nitrate and N2O production were greatly enhanced by an ammonium enrichment after the emergence of nitrification activity. From both vertical observations and incubation experiments, the yield of N2O relative to nitrate production was estimated to be 0.1% during the period of active nitrification. Thereafter, yields were appreciably higher. Another incubation experiment also showed that N2O production was delayed several days compared to nitrate production, indicating that N2O production was accelerated in the last phase of nitrification. The physiological state of nitrifiers is suggested to be of some importance for such phenomena. Nitrapyrin, a specific inhibitor of nitrification, was not very effective for N2O formation, whereas nitrate production was completely inhibited, suggesting the possibility of some sources of N2O other than autotrophic nitrification. (Author's abstract)
W91-07869

GEOCHEMICAL STUDIES ON THE COASTAL LAKES OF KAMIKOSHIKI ISLAND IN KAGOSHIMA PREFECTURE, JAPAN: I. A PRELIMINARY REPORT.
Tokyo Metropolitan Univ. (Japan). Dept. of Chemistry.
K. Fukushima, H. Kondo, M. Ochiai, H. Uemura, and M. Uzaki.
Japanese Journal of Limnology RIZAAU, Vol. 51, No. 4, p 261-268, October 1990. 8 fig, 2 tab, 16 ref. English summary.

Descriptors: *Coasts, *Geochemistry, *Japan, *Lake sediments, *Lakes, *Limnology, *Sediment chemistry, Alcohols, Amino acids, Bacteria, Brackish water, Carbohydrates, Carbon radioisotopes, Chemical composition, Fatty acids, Hydrocarbons, Lipids, Organic matter, Particulate matter, Sampling.

In the coastal region of Kamikoshiki Island, Kagoshima Prefecture of Japan, there are Lakes Namako-ike, Kai-ike, Kazaki-ike, and Suguchi-ike. All four lakes are separated from the sea by a long gravel bar. Although these lakes are believed to have been formed in the same geological period (5,000-10,000 yr BP), the ensuing geological succession has significantly differentiated their geochemical and biological situations. A study was undertaken to determine how these differences in ecological conditions reflect the chemical composition of the underlying sediments. Sediment samples were collected with a grab sampler from three of the lakes. In Lake Kai-ike, particulates were collected from near the phototropic 'bacterial plate' peculiar to the lake. The stable carbon isotope ratio

of the sedimentary organic matter was light (-25 ppt) for slightly saline Lake Kazaki-ike, while the values around -22 ppt for brackish Lake Kai-ike and Lake Namako-ike were thought to indicate a higher contribution from authigenic marine biota. However, only slight differences were observed with regard to the major identifiable organic constituents examined, i.e., amino acids, carbohydrates, and lipids (hydrocarbons, alcohols, and fatty acids). The lipid compositions, influenced little by anthropogenic pollutants, were considered to represent a contribution primarily from the anaerobic bacterial community. (Author's abstract)
W91-07870

DISSOLVED ORGANIC MANGANESE IN THE INTERSTITIAL WATER OF LAKE FUKAMI-IKE.
Nagoya Women's Univ. (Japan). Faculty of Home Economics.
A. Yagi.
Japanese Journal of Limnology RIZAAU, Vol. 51, No. 4, p 269-279, October 1990. 7 fig, 25 ref.

Descriptors: *Interstitial water, *Lakes, *Limnology, *Manganese, *Metal complexes, *Trace metals, *Water chemistry, Adsorption, Dissolved organic carbon, Japan, Organic matter, Regression analysis, Resins, Speciation, Ultrafiltration.

Vertical profiles of dissolved manganese were examined in the interstitial water of monomictic Lake Fukami-ike (Japan) from October 1987 to June 1988. The speciation of dissolved manganese in the interstitial water was performed by ultrafiltration (Mn(UF)) and by adsorption on XAD-2 resin (Mn(XAD-2)). On passing the ultrafiltrates through an XAD-2 column, the percentages of Mn(XAD-2) at neutral pH were 0.3% to 8.0% (molecular weight fraction < 1,000); 14.8% to 50.9% (MW between 1,000 and 50,000); 3.7% to 20.0% (MW between 50,000 and 200,000); and 7.0% to 19.6% (MW > 200,000) of the total manganese in interstitial waters. The amounts of Mn(XAD-2) at neutral pH in interstitial waters were 82% to 95% of Mn(UF) fractionated into three high molecular weights. About 41% to 77% of the total dissolved manganese in the interstitial water was present in organic forms associated mainly with a molecular weight of 1,000 to 50,000. Regression plots of dissolved organic manganese vs. dissolved organic carbon in the two high molecular weight fractions (50,000-200,000 and 1,000-50,000) showed good linear correlations (r = 0.54 and 0.85) with slopes of 0.045 and 0.070, respectively. This suggests that manganese is mainly associated with dissolved organic matter having a molecular weight of 1,000-50,000 and 50,000-200,000, and the average molar ratios of dissolved organic carbon to dissolved organic manganese are 60:1 and 75:1, respectively. (Author's abstract)
W91-07871

ORGANICALLY BOUND IRON IN LAKE SEDIMENTS AND ITS AVAILABILITY TO UROGLENA AMERICANA, A FRESHWATER RED TIDE CHRYSOPHYCEAE.
Osaka City Inst. of Public Health and Environmental Sciences (Japan).
T. Nishio, and Y. Ishida.
Japanese Journal of Limnology RIZAAU, Vol. 51, No. 4, p 281-291, October 1990. 9 fig, 1 tab, 46 ref.

Descriptors: *Algal growth, *Chrysophyta, *Iron, *Lake sediments, *Limnology, *Red tide, Bioassay, Cation exchange, Growth, Interstitial water, Metal complexes, Organic compounds, Phytoplankton, Speciation, Ultrafiltration.

Organically bound iron in the interstitial water of sediment from a lagoon near Lake Biwa (Japan) was fractionated successively by ultrafiltration, cation exchange, and gel filtration. Each fraction was bioassayed for iron availability to the freshwater red tide chrysophyte Uroglena americana. Iron bound to anionically charged ninhydrin-reactive organic compounds (molecular weight around 300-600 dalton) promoted the growth of U. americana. The iron-complexing capacity of interstitial water was estimated at about 14 microM as an equivalent concentration of iron available to U. americana. (Author's abstract)
W91-07872

SEASONAL FLUCTUATION OF PHYTOPLANKTON WITH SPECIAL REFERENCE TO THE CHRYSOPHYTES IN FOUR PONDS AND LAKES SITUATED IN THE SOUTHERN PART OF HYOGO PREFECTURE, JAPAN.
Kobe City Water Works Bureau (Japan). Water Quality Lab.
H. Ito.
Japanese Journal of Limnology RIZAAU, Vol. 51, No. 4, p 293-305, October 1990. 8 fig, 3 tab, 42 ref. English summary.

Descriptors: *Chrysophyta, *Eutrophication, *Japan, *Lake ecology, *Limnology, *Phytoplankton, *Water pollution effects, Algae, Eutrophic lakes, Lakes, Oligotrophic lakes, Ponds, Population density, Reservoirs, Seasonal variation, Species composition, Temperature, Trophic level.

Seasonal fluctuation of phytoplankton was studied in four ponds and lakes in Japan, which are in different stages of eutrophication. Chrysophytes increased in cell number from autumn to spring. The maximum density of chrysophytes was recorded in March in all the ponds and lakes: 5,900 cells/ml in Doro-ike Pond, 13,000 cells/ml in Hoshino-ike Pond, 190 cells/ml in Sengari Reservoir, and 6,900 cells/ml in Yasuba-ike Pond. Chrysophytes were an abundant algal group in the low temperature period; Mallomonas akrokomos, Synura mammillosa, Chrysococcus rufescens, and Dinobryon sociale were dominant in the freezing period. Many chrysophyte species occurred not only in oligotrophic waters but also in eutrophic ones, and the number of species increased with eutrophication. Chrysophytes appeared year round in oligotrophic waters, whereas in eutrophic waters they appeared in the low temperature period with higher density than in oligotrophic waters. In heavily polluted waters where water blooms of cyanophytes occurred, the number and density of species were very low. Based on these observations, chrysophytes are regarded as representatives of eutrophic waters as well as of oligotrophic ones. (Author's abstract)
W91-07873

NET PRIMARY PRODUCTION OF NYMPHOIDES PELTATA (GMEL.) O. KUNTZE GROWING ON SANDY SEDIMENT AT EDOSAKI-IRI BAY IN LAKE KASUMIGAURA, JAPAN.
Chiba Univ. (Japan). Dept. of Biology.
T. Tsuchiya, S. Nohara, and T. Iwakuma.
Japanese Journal of Limnology RIZAAU, Vol. 51, No. 4, p 307-312, October 1990. 4 fig, 1 tab, 18 ref.

Descriptors: *Aquatic plants, *Eutrophic lakes, *Floating plants, *Japan, *Limnology, *Primary productivity, Biomass, Lake Kasumigaura, Lake ecology, Leaves, Littoral environment, Phytoplankton, Seasonal variation, Sediments.

Lake Kasumigaura, located 60 km northeast of Tokyo, Japan, is a eutrophic lake. Estimates were made of net production of Nymphoides peltata, a perennial floating-leaved plant, growing on sandy sediments at the littoral zone of a southern bay of the lake (Edosaki-iri Bay). The seasonal maximum biomass of N. peltata was only 47.6 g dry weight/sq m in late September. Leaf life span was 28 days and thus biomass turnover rate was estimated at 3.4 for 200 days, comparable with rates reported for floating-leaved plants and much higher than other herbaceous plants. Yearly net production per unit ground area was estimated at 182 g dry weight/sq m. This value is smaller than that reported for phytoplankton at the same site and for floating-leaved plants growing at other regions of this lake. It is concluded that N. peltata is not an important primary producer at Edosaki-iri Bay. (Doria-PTT)
W91-07874

WATER AND SALT REGIME OF THE ARNASAI LAKES.
For primary bibliographic entry see Field 6G.
W91-07879

REGIONALIZED ESTIMATION OF RESERVOIR CAPACITY-YIELD CURVES IN HUNGARY.
Vizgazdalkodasi Tudomanyos Kutato Intezet, Budapest (Hungary).
For primary bibliographic entry see Field 2E.
W91-07945

INFLUENCE OF LIGHT AND TEMPERATURE ON THE GROWTH OF FOUR ALGAE FROM A EUTROPHIC LAKE (LAKE AYDAT, PUY DE DOME, FRANCE) (INFLUENCE DE LA LUMIERE ET DE LA TEMPERATURE SUR LA CROISSANCE DE QUATRE ESPECES D'ALGUES D'UN LAC EUTROPHE (LAC AYDAT, PUY DE DOME, FRANCE)).
Clermont-Ferrand-2 Univ., Aubiere (France). Lab. de Zoologie et Protistologie.
L. Boumnich, A. Dauta, J. Devaux, and J. C. Romagoux.
Annales de Limnologie ANLIB3, Vol. 26, No. 1, p 3-10, 1990, 6 fig, 25 ref. English summary.

Descriptors: *Algae, *Algal growth, *Eutrophic lakes, *France, *Light effects, *Limnology, *Temperature effects, Competition, Computer models, Culturing techniques, Limiting nutrients, Phytoplankton, Succession.

In lake and ocean ecosystems, the phytoplanktonic biomass is often described as the succession of a limited number of dominant species which constitute the most productive fraction, the development of which may be due to physical, chemical, and/or biological factors. In spite of the number of studies dedicated to the ecology of phytoplankton, the interdependence between light and temperature still remains poorly quantified. Light and temperature relationships were studied in batches under non-nutrient-limited conditions for single-strain, non-axenic cultures of four algal species: Fragilaria crotonensis, Anabaena macrospora, Staurastrum pingue, and Coelastrum cambricum. The maximum growth rates were found to be 0.57, 0.63, 0.77 and 1.4 per day, respectively, at temperatures of 25, 25, 27, and 35 C and light intensities of 150, 170, 270, and 290 microE/sq m/s. Results were obtained over a temperature range of 10 to 35 C and light intensities between 5 and 800 microE/sq m/s under a 15/9 photoperiod and were adjusted using a computer model of phytoplankton population dynamics. These results obtained with non-limiting nutritional conditions, together with previous studies of the assimilation and storage of the principal nutrients (N, P, Si), permit the determination of the conditions under which these species compete in the natural environment. (King-PTT)
W91-07982

SEASONAL ZOOPLANKTON PATTERNS IN A SHALLOW OLIGOTROPHIC LAKE: LOCH RUSKY (SCOTLAND).
Valencia Univ. (Spain). Dept. of Ecology.
S. Romo.
Annales de Limnologie ANLIB3, Vol. 26, No. 1, p 11-17, 1990, 4 fig, 1 tab, 15 ref.

Descriptors: *Limnology, *Loch Rusky, *Oligotrophic lakes, *Population dynamics, *Scotland, *Zooplankton, Copepods, Fish stocking, Rotifers, Shallow water, Species composition, Waterfleas.

The zooplankton taxa and their seasonal distribution are described for Loch Rusky, a shallow oligotrophic lake in the central region of Scotland. Fifteen species were identified: 11 Rotifera, 2 Cladocera and 2 Copepods. Only 5 species (Polyarthra remata, Keratella cochlearis, Filinia terminalis, Trichocercra sp., and Eudiaptomus gracilis) occurred in sufficient numbers to facilitate a description of their seasonal pattern. The annual zooplankton variation was dominated by rotifers for most of the year, but copepods (E. gracilis and Cyclops sp.) were dominant in the epilimnion during summer. It is presumed that this pattern was the result of the rotifers' faster rate of reproduction and higher grazing efficiency under oligotrophic conditions, as well as the decrease of larger zooplankton by the continuous program of fish stocking in the lake. Loch Rusky showed in general a zooplankton

community similar in species composition to that described in small oligotrophic lakes of the Pyrenees and in oligotrophic temperate lakes. (Author's abstract)
W91-07983

FISH POPULATIONS OF SIX ANCIENT ARMS OF THE GARONNE RIVER.
Ecole Nationale Superieure Agronomique de Toulouse (France). Lab. d'Ichthyologie Appliquee.
A. Belude, D. Bengen, and P. Lim.
Annales de Limnologie ANLIB3, Vol. 26, No. 1, p 81-90, 1990, 4 fig, 4 tab, 20 ref. English summary.

Descriptors: *Aquatic habitats, *Fish populations, *France, *Garonne River, *Limnology, *Oxbow lakes, *Species composition, Biological samples, Ecological distribution, Gimone River, Lentic environment, Species diversity, Stream biota.

Fish populations were surveyed in 'ancient arms' (river meanders which are at various stages of becoming oxbow lakes) at six sites in the Garonne River between Toulouse and its confluence with the Gimone. Sampling was done by electro-fishing and the use of gillnets. These samples made it possible to establish ecological indices and species associations. Species distribution profiles were then associated with environmental variables. The results reflect the diversity of fish populations and differences between the side-arms of the Garonne river. Ancient arms which have an important connection with the river have the richest and most varied faunas. Spatial distributions of the major species show two important associations. Deep zones with a gravel substrate are favorable for roach, bream, bleak, rudd, and black bass. The shallow waters of the gently sloping shorelines are colonized by aquatic vegetation which is an attractive habitat for bottom-feeders and other carnivores (perch and sunfish). (Author's abstract)
W91-07985

STUDY ON THE MODEL OF LAKE-SWAMP INTER-EVOLUTION (IN CHINESE).
Changchun Inst. of Geography (China).
G. Y. Sun.
Oceanologia et Limnologia Sinica (Hai Yang Yu Hu Chao) HYHCAG, Vol. 21, No. 5, p 485-489, 1990, 5 fig, 5 ref. English summary.

Descriptors: *China, *Geomorphologic evolution, *Lakes, *Limnology, *Swamps, *Wetlands, Geologic history, Lake stages, Model studies, Succession, Theoretical analysis, Xihu Lake.

According to the classical theory, a lake may evolve into a swamp or swampy lake. After a lake is formed, swamp will start to encroach slowly towards the center of the lake, resulting in the gradual disappearance of the lake. But new data obtained from the Xihu Lake of Eryuan County, Yunnan Province, China, indicates that a lake can also originate as a swamp. The center part of the lake was formerly occupied by swamp. Following a gradual depression of the earth's crust, the water became too deep, and a lake gradually took shape. Taking into consideration both the classical theory and the new data, a systematic model is proposed for the evolution of land into swamp, into lake, into swamp, and into land again, a cycle reflecting the basic laws of environmental succession. (Author's abstract)
W91-07987

BENTHIC MACROFAUNA OF OX-BOW LAKES AND THE INFLUENCE ON THE MACROINVERTEBRATE COMMUNITIES OF THE PARENT STREAM.
Technische Univ. Braunschweig (Germany, F.R.). Zoologisches Inst.
G. E. Rehfekdt, and W. Soechtig.
Zeitschrift fuer Wasser- und Abwasser Forschung ZWABAQ, Vol. 23, No. 6, p 228-232, December 1990, 2 fig, 4 tab, 29 ref.

Descriptors: *Aquatic habitats, *Lake ecology, *Lentic environment, *Limnology, *Oxbow lakes, *Stream biota, Benthic fauna, Food chains, Germany, Macroinvertebrates, Primary productivity, Water chemistry.

Two oxbow lakes whose downstream ends connect with the river Innerste, in Lower Saxony, Germany, were sampled by several methods. Compared with the river, most hydrochemical parameters of these standing waters exhibited greater annual fluctuations. The low content of nitrogen compounds and dissolved orthophosphates during the study period indicated high primary productivity in the lakes. In the macrobenthic communities, carnivorous species (53% of the total number of individuals) and scrapers (Gastropoda, Chironomidae) dominated, while in the river downstream of the lakes filter-feeding and detritus-feeding organisms (92.1%--Trichoptera and Ephemeroptera) occurred at extremely high densities. Most species of the highly productive macrobenthic community of the lakes were typical of cool, mesotrophic to eutrophic, standing waters. Detritus and small drifting benthic organisms from the oxbow lakes may pass directly into the food chain of the river, increasing the trophic level and influencing the structure of its macroinvertebrate community. (Author's abstract)
W91-07991

PRODUCTION, NUTRIENT DYNAMICS AND INITIAL DECOMPOSITION OF FLOATING LEAVES OF NYMPHAEA ALBA L. AND NUPHAR LUTEA (L.) SM. (NYMPHAEACEAE) IN ALKALINE AND ACID WATERS.
Katholieke Univ. Nijmegen (Netherlands). Lab. of Aquatic Ecology.
C. J. Kok, G. Van der Velde, and K. M. Landsbergen.
Biogeochemistry BIOGEP, Vol. 11, No. 3, p 235-250, December 1990. 6 fig, 3 tab, 34 ref.

Descriptors: *Acidic water, *Alkaline water, *Aquatic plants, *Cycling nutrients, *Decomposition, *Leaves, *Water pollution effects, Litter, Nutrients, Primary production, The Netherlands, Water chemistry, Water quality.

Production, turnover and nutrient dynamics of floating leaves of Nymphaea alba L. and Nuphar lutea (L.) Sm. were studied in four aquatic systems in The Netherlands, differing strongly in water quality. Production was 108-447 g ash-free dry weight (AFDW)/sq m for N. lutea and 319-348 g AFDW/sq m for N. alba. Turnover ranged from 3.6 to 4.4 without much difference between the sites and the species. During senescence 60-70% of the N and P from the leaves was resorbed by both of the plant species. The nutrient flow from the floating leaves into the detritus food chain differed considerably between the species and sites studied, mainly because of the differences in production. The data suggest that production is strongly influenced by the environment, whereas turnover and nutrient resorption during senescence seem to be plant characteristics. There was little difference in dynamics of the chlorophyll-a concentration in the leaves of the two species, irrespective of the growing site. Floating leaves of both species lost about 70% of their area due to fragmentation in the alkaline waters, whereas in the acid water very little fragmentation was observed. (Author's abstract)
W91-08012

MOLECULAR CHARACTERIZATION OF TOTAL ORGANIC MATTER AND CARBOHYDRATES IN PEAT SAMPLES FROM A CYPRESS SWAMP BY PYROLYSIS-MASS SPECTROMETRY AND WET-CHEMICAL METHODS.
Technische Hogeschool Delft (Netherlands). Vakgroep Microgolftechniek.
M. E. C. Moers, M. Baas, J. J. Boon, and J. W. De Leeuw.
Biogeochemistry BIOGEP, Vol. 11, No. 3, p 251-277, December 1990. 6 fig, 2 tab, 90 ref.

Descriptors: *Degradation, *Limnology, *Organic matter, *Peat, *Plants, *Wetlands, Chemical analysis, Gas chromatography, Georgia, Mass spectrometry, Polysaccharides, Spectrometry, Swamps.

The organic matter present in coarse-grained and fine-grained sample preparations of a peat core from Minnie's Lake, Okefenokee Swamp (Georgia) was analyzed on a molecular level by gas chromatography-mass spectrometry of alditol acetates obtained from polysaccharides after acid hydrolysis and derivatization by flash pyrolysis-mass spectrometry (Py-MS). It was found that the coarse-grained fraction is dominated by neutral monosaccharides derived from vascular plants while the fine-grained fraction is dominated by neutral monosaccharides derived from microorganisms. Relatively high contributions of xylose discriminate the Taxodium derived peat from the underlying peats derived from Carex and Nymphaea which show relatively low contributions of this sugar. Factor-discriminant analysis of the Py-MS data indicated that most carbohydrate degradation is restricted to the upper peat levels and that guaiacyl and syringyl type lignins are better preserved than carbohydrates. Resinous organic matter, presumably derived from Taxodium, is selectively preserved in the fine-grained fraction. Deviant monosaccharide concentrations and Py-MS results observed for the top sample of the Carex peat were explained by oxygenation of the peat, a concomitantly high microbial activity and subsequent preservation of the organic material due to the action of phytotoxins derived from Taxodium. (Author's abstract)
W91-08013

BIODEGRADATION AND ANTICHOLINESTERASE ACTIVITY OF METHYL ISOCYANATE IN THE AQUATIC ENVIRONMENT OF BHOPAL.
National Inst. of Oceanography, Panaji (India).
For primary bibliographic entry see Field 5C.
W91-08052

EFFECT OF CARBON DIOXIDE EQUILIBRIUM ON PH IN DILUTE LAKES.
Cornell Univ., Ithaca, NY. School of Civil and Environmental Engineering.
J. J. Bisogni, and S. L. Arroyo.
Water Research WATRAG, Vol. 25, No. 2, p 185-190, February 1991. 8 fig, 5 tab, 25 ref.

Descriptors: *Acid rain effects, *Acidification, *Analytical methods, *Carbon dioxide, *Hydrogen ion concentration, *Lake acidification, Acid lakes, Acid neutralizing capacity, Acidity, Carbon, Equilibrium, Humic substances, Hypolimnion, Lakes.

Difficulties in measuring in situ pH in dilute acidified lakes have often resulted in an assumption of atmospheric carbon dioxide equilibrium to compute this pH. Unfortunately, the sensitivity of pH to carbon dioxide content of dilute waters is high. The results of an experimental study conducted at Wolf Pond (Franklin County, New York) show the carbon dioxide equilibrium is seldom attained in a dilute lake. This effect is most significant in hypolimnetic regions. As a result, invoking an atmospheric equilibrium assumption can lead to pH estimation errors of greater than one pH unit at pH = 6. A more accurate method to estimate in situ pH is presented. The method uses measured acid neutralizing capacity and total inorganic carbon. Contribution of humic substances to acid neutralizing capacity is taken into account. (Author's abstract)
W91-08053

ENHANCED BIOLOGICAL CONTROL OF WATERHYACINTH FOLLOWING LIMITED HERBICIDE APPLICATION.
Florida Univ., Gainesville. Dept. of Entomology.
For primary bibliographic entry see Field 4A.
W91-08072

EFFICACY OF EARLY-SEASON FLURIDONE TREATMENT FOR MANAGEMENT OF WATERMEAL, WOLFFIA COLUMBIANA KARST.
North Carolina State Univ. at Raleigh. Dept. of Crop Science.
For primary bibliographic entry see Field 4A.
W91-08075

MEASUREMENT OF LIGHT ABSORPTION COEFFICIENT IN LAKE BAIKAL WATER MEDIA (IN RUSSIAN).
Irkutskii Gosudarstvennyi Univ. (USSR).
For primary bibliographic entry see Field 7B.
W91-08084

STAGNANT WATER ECOSYSTEMS IN MOROCCO: BIOTYPOLOGICAL STUDIES OF THE ZOOPLANKTON (LES EAUX STAGNANTES AU MAROC: ETUDES BIOTYPOLOGIQUE ET BIOGEOGRAPHIQUE DU ZOOPLANCTON).
Institut Scientifique, Rabat (Morocco).
M. Ramdani.
Travaux de l'Institut des Sciences, Rabat, Serie Zoologique, No. 43, p 1-40, 1988. 15 fig, 14 tab, 88 ref. English summary.

Descriptors: *Aquatic habitats, *Biogeography, *Morocco, *Stagnant water, *Zooplankton, Bioindicators, Chemical properties, Copepods, Crustaceans, Deserts, Food chains, Humid areas, Mediterranean, Mountains, Rainfall, Semiarid lands, Swamps, Temperature, Thermal effects, Waterfleas.

A study of the stagnant water ecosystems in Morocco was undertaken between 1978 and 1985, and observations of the zooplanktonic species were compared with previous observations made in Morocco and the occidental Mediterranean area. There were 125 stations, which are described on the basis of morphological, hydrological, thermal, and chemical components. Subhumid and semi-arid areas present various biotopes for stagnant water; humid and desert regions are less suitable for these aquatic formations. Copepods and cladocerans were studied because these groups are good indicators of the ecology of stagnant waters, and provide a basis for the food chain for other aquatic invertebrates and vertebrates. On the basis of crustacean sampling, 111 taxa were recorded, of which 15 are new for the country. A first biotypology based on copepods and cladocerans delineates four categories off aquatic areas: dayas, sebkhas, merjas, and aguelmanes. This structure depends in part on salinity. The second analysis divided dayas into four models as a function of temperature and rainfall. In the Moroccan and North African communities a high degree of affinity was found between Ethiopian, European, and West Mediterranean subregions. The endemism in Morocco is reinforced by atlasic and rifian mountains. (Author's abstract)
W91-08086

DISTRIBUTION OF NITROGEN SPECIES IN POLLUTED ONONDAGA LAKE, N.Y., U.S.A.
Upstate Freshwater Inst., Inc., Syracuse, NY.
For primary bibliographic entry see Field 5B.
W91-08117

FATES OF RADIOTRACERS ADDED TO A WHOLE LAKE: ACCUMULATION IN FATHEAD MINNOW (PIMEPHALES PROMELAS) AND LAKE TROUT (SALVELINUS NAMAYCUSH).
Department of Fisheries and Oceans, Winnipeg (Manitoba). Freshwater Inst.
For primary bibliographic entry see Field 5B.
W91-08119

WATER QUALITY OF THE WEST BRANCH LACKAWAXEN RIVER AND LIMNOLOGY OF PROMPTON LAKE, WAYNE COUNTY, PENNSYLVANIA, OCTOBER 1986 THROUGH SEPTEMBER 1987.
Geological Survey, Harrisburg, PA. Water Resources Div.
For primary bibliographic entry see Field 5B.
W91-08184

2I. Water In Plants

RELATIONSHIP BETWEEN NITROGEN FIXATION AND TIDAL EXPORTS OF NITROGEN IN A TROPICAL MANGROVE SYSTEM.
Australian Inst. of Marine Sciences, Townsville.
K. G. Boto, and A. I. Robertson.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 31, No. 5, p 531-540, November 1990. 2 tab, 22 ref.

Descriptors: *Australia, *Ecosystems, *Mangrove swamps, *Mangrove trees, *Nitrogen cycle, *Nitrogen fixation, *Nutrient transport, *Wetlands, Algal mats, Cyanophyta, Decomposition, Dissolved solids, Particulate matter, Plant physiology, Primary productivity, Seasonal variation, Sediment chemistry, Temporal distribution, Tides.

Various components (sediments, algal mats, decomposing logs and algal-covered prop roots) of a tropical mangrove forest in northern Australia, showed low to moderate nitrogen fixation (acetylene reduction) rates. Measurements carried out in March, May and October 1989 revealed negligible or inconsistent seasonal variation in activity for all components. Prop roots with their associated algae showed much greater activity during night-time, typical of many substrates with associated cyanobacteria, whereas all other components had constant activity over 24 hour periods. Extrapolation of the nitrogen fixation for each component to a 'whole-forest' basis, using field estimates of the densities of each component, indicated that sediments, prop roots and decomposing logs contributed approximately 3.5, 1.6 and 1.0%, respectively, of the nitrogen requirements for forest net primary production (FPPN). Blue-green algal mats on bare saltpan areas showed no significant nitrogen-fixing activity (in excess of that for the bare sediments in the same area. The total nitrogen contribution of the various components (6% of FPPN) closely matches previous estimates of the net nitrogen loss from the system through tidal fluxes of particulate and dissolved materials. (Author's abstract)
W91-07310

LONGITUDINAL DIFFUSION IN MANGROVE-FRINGED TIDAL CREEKS.
James Cook Univ. of North Queensland, Townsville (Australia). Dept. of Physics.
P. V. Ridd, E. Wolanski, and Y. Mazda.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 31, No. 5, p 541-554, November 1990. 7 fig, 13 ref.

Descriptors: *Cycling nutrients, *Mangrove swamps, *Nutrient transport, *Swamps, *Tidal rivers, *Wetlands, Coastal environment, Comparison studies, Diffusion coefficient, Estuaries, Evaporation, Evapotranspiration, Headwaters, Mathematical models, Model studies, Path of pollutants, Residence time, Turbulence.

In order to understand the role of mangroves in the nutrient cycle and the exchange of nutrients between the swamp and the near-shore zone, the mixing characteristics of the swamp must be analyzed. The longitudinal diffusion coefficient and flushing times of mangrove-fringed tidal creeks were determined analytically and numerically. The tidally averaged diffusion coefficient was found to be dependent on the square of the distance from the head of the creek. The effect of turbulent diffusion was negligible compared with the dispersion due to the trapping effect of the mangroves. Calculations predict a residence time for pollutants introduced into the creek on the order of about 10 days for a creek 10 km long. This long residence time only exists within the first 3 or 4 km from the head of the creek as the high value of the diffusion coefficient closer to the mouth flushes the estuary to the near-shore zone very efficiently. The results of both the analytical and numerical models were compared with data on the flushing of freshwater following a short-lived flood, and salt accumulation due to evaporation and evapotranspiration. The results agree well with the experimental data. (Author's abstract)
W91-07311

ATMOSPHERE AND THE RHIZOSPHERE: LINKAGES WITH POTENTIAL SIGNIFICANCE FOR FOREST TREE HEALTH.
Yale Univ., New Haven, CT. School of Forestry and Environmental Studies.
For primary bibliographic entry see Field 2G.
W91-07471

EFFECT OF NPKS FERTILIZATION ON THE NATURAL GRASSLANDS OF MAGALLANES AND ITS MODIFICATION DUE TO SOIL AND CLIMATIC FACTORS (RESPUESTA DE LAS PRADERAS DE MAGALLANES A LA FERTILIZACION NPKS Y SU MODIFICACION POR FACTORES DE SUELO Y CLIMA).
Estacion Experimental Kampenaike, Punta Arenas (Chile).
For primary bibliographic entry see Field 3F.
W91-07520

EFFECTS OF SEASONAL DROUGHT ON OLD-FIELD PLANT COMMUNITIES.
Miami Univ., Oxford, OH. Dept. of Zoology.
E. K. Bollinger, S. J. Harper, and G. W. Barrett.
American Midland Naturalist AMNAAF, Vol. 125, No. 1, p 114-125, January 1991. 3 fig, 4 tab, 50 ref. EPA Grant R-812385-01.

Descriptors: *Drought effects, *Fertilizers, *Plant populations, *Primary productivity, *Sludge utilization, *Succession, Annuals, Nutrients, Perennials, Precipitation, Species diversity, Water stress.

The effects of the 1988 drought on old-field plant communities treated with contrasting types of nutrient subsidies were studied. The study site was divided into eight 0.1 ha plots: 3 plots received monthly applications of sludge (Milorganite; 6-2-0, N-P-K); 3 plots received an equivalent subsidy of fertilizer, and 2 plots were left as untreated controls. Control plots were dominated by perennials (especially Solidago and Poa), whereas the nutrient-enriched plots were dominated by summer annuals (especially Setaria and Ambrosia) and resembled old fields in the initial stages of secondary succession. Control plots had greater species richness and diversity but lower productivity than nutrient-enriched plots of several years preceding 1988. Daily aboveground net primary productivity (NPP) for July 1988 samples, when drought stress was most severe, was 45% of the 1985-1987 mean for control plots but only 17% and 11% for sludge and fertilizer plots, respectively. This pattern was reversed in August 1988 following alleviation of the drought due to above-normal precipitation. Daily NPP in August 1988 in sludge and fertilizer plots were 224% and 140%, respectively, of the 1985-1987 average, compared to 100% for control plots. Thus, primary productivity in perennial-dominated plant communities (control plots) was not as depressed during the peak of the drought as in the annual-dominated, nutrient-enriched plots. However, the nutrient-enriched communities exhibited more rapid responses to the alleviation of drought stress than the perennial-dominated communities. Species diversity (H') was lower during the drought stress in control plots when compared to the 1985-1987 average whereas H' in sludge and fertilizer plots was not affected. However, after the drought, H' in sludge plots was over twice the 1985-1987 mean. In contrast, species richness was not significantly affected by drought stress in any of the treatments. (Author's abstract)
W91-07551

LARGE, RETRACTABLE, LOW COST AND RELOCATABLE RAIN OUT SHELTER DESIGN.
Queensland Dept. of Primary Industries, Kingaroy (Australia). J. Bjelke Petersen Research Station.
P. M. Hatfield, G. C. Wright, and W. R. Tapsall.
Experimental Agriculture EXAGAL, Vol. 26, No. 1, p 57-62, 1990. 4 fig, 8 ref. Australian Centre for International Agricultural Research (ACIAR) Project 8419.

Descriptors: *Automation, *Crop production, *Drought effects, *Field tests, *Plant-water relationships, *Rain out shelter, *Soil-water-plant relationships, Analytical methods, Cost analysis, Experimental design, Rainfall, Remote sensing, Sampling.

The success of drought studies in the field often depends on the exclusion of rainfall at critical

stages of crop development. A number of devices to exclude rainfall in the field, often referred to as rain out shelter, have been described and reviewed extensively. The design of a low cost and relocatable rain out shelter is presented. It allows large areas to be protected so that relatively large plots can be used to reduce edge effects and sampling errors. The retractability of the vinyl cover minimizes disturbance to the surrounding crop microenvironment, which is a major problem with fixed roof types. An electronic sensing device is currently being developed so that the extension and retraction of the vinyl sheet can be fully automated. (Medina-PTT)
W91-07566

GRAIN AND FORAGE YIELD AND STOVER QUALITY OF SORGHUM AND MILLET IN LOW RAINFALL ENVIRONMENTS.
INTSORMIL, Gaborone (Botswana).
J. B. Youngquist, D. C. Carter, and M. D. Clegg.
Experimental Agriculture EXAGAL, Vol. 26, No. 3, p 279-286, 1990. 3 tab, 22 ref.

Descriptors: *Agricultural practices, *Botswana, *Crop production, *Drought effects, *Forages, *Grain crops, Arid lands, Cattle, Grazing, Millet, Sorghum, Stover quality.

Botswana farmers are economically dependent upon the cattle industry. The drought that started in 1981 resulted in severe overgrazing of pasture and large losses of cattle. Although crop yields have suffered, crop residues remain an important feed source between May an November. The potential for using sorghum and millet crop residues as fodder was studied in southeastern region of the country which is characterized by low, unevenly distributed rainfall and shallow sandy soils. Yield, in vitro dry matter digestibility (IVDMD), and nutrient content were evaluated to determine deficiencies and potential toxicity problems. There were significant differences among cultivars for grain and stover yield, digestibility, crude protein, and mineral content. Stover from all strains was adequate for cattle maintenance in IVDMD including most of the minerals tested. However, crude protein and phosphorus levels did not always meet the minimum requirement. The deficient phosphorus levels were compounded by high calcium levels. This mineral imbalance could lead to bone abnormalities and reduce fertility in livestock. (Medina-PTT)
W91-07567

ROOT RESPONSE TO WATER STRESS IN RAINFED LOWLAND RICE.
International Rice Research Inst., Los Banos, Laguna (Philippines). Dept. of Agronomy.
M. Thangaraj, J. C. O'Toole, and S. K. De Datta.
Experimental Agriculture EXAGAL, Vol. 26, No. 3, p 287-296, 1990. 8 fig, 17 ref.

Descriptors: *Crop production, *Drought effects, *Plant-water relationships, *Rice, *Root growth, *Water stress, Crop yield, Field tests, Flooding, Greenhouses, Plant water potential, Soil water.

Although rice is grown in diverse cultural systems, larger and more stable yields are generally obtained under submerged lowland conditions where lack of water is often a major constraint. During water stress, water use and nutrient uptake are determined primarily by root system density and depth. The relation between soil mechanical impedance as a result of soil drying, and root system growth (mass and length density) of rice was investigated in greenhouse and field studies. In a greenhouse experiment, soil drying for 16 days increased mechanical impedance in the 0-20 cm soil layer from near 0 to 2.5 MPa (water potential), and decreased root growth by 47% compared to the continuously flooded control. Root length density decreased with decreasing soil moisture and increasing soil mechanical impedance. In a lowland field experiment using a sprinkler irrigation gradient treatment for 19 days during the vegetative growth stage, soil mechanical impedance as low as 0.01 MPa inhibited root growth while values greater than 0.3-0.5 MPa decreased root growth and extension by 75%. The relative loss of potential root growth was continued after reflooding. Root length density, measured at flowering, was linearly related to yield. (Author's abstract)
W91-07568

EFFECT OF CUMULATIVE EROSION AND RAINFALL ON SORGHUM, PEARL MILLET AND CASTOR BEAN YIELDS UNDER DRY FARMING CONDITIONS IN ANDHRA PRADESH, INDIA.
Central Research Inst. for Dryland Agriculture, Hyderabad (India).
K. P. R. Vittal, K. Vijayalakshmi, and U. M. B. Rao.
Experimental Agriculture EXAGAL, Vol. 26, No. 4, p 429-439, 1990. 5 fig, 2 tab, 19 ref.

Descriptors: *Crop yield, *Dry farming, *India, *Rainfall impact, *Soil erosion, *Soil-water-plant relationships, Castor bean, Mathematical models, Pearl millet, Slope effects, Sorghum, Topsoil.

The intense rainfall characteristics of the semi-arid tropics of India cause erosion of the topsoil from complex slopes. A technique for the preparation of a continuous in situ topsoil gradient under field conditions which emulates the natural changes in soil depth associated with hill slopes is presented. Responses of the principal crops of the region to variations in topsoil depth under varying conditions on this gradient were studied. Topsoil depth and yields of sorghum, pearl millet and castor bean were positively correlated when monitored over thirteen seasons under widely varying rainfall conditions on an Alfisol in Andhra Pradesh. Yield responded up to 2.5 times more to topsoil depth when rainfall in the critical period exceeded evapotranspiration than under drier conditions. Yield variations were attributed to topsoil depth in cereals, and by the interaction between rainfall during the critical period and topsoil depth in cereals and castor bean. The expected yield losses as a result of erosion, based on 56 years of rainfall data, were 138, 84 and 51 kg/ha/cm for sorghum, pearl millet and castor bean, respectively. Quadratic models explained the yield losses due to cumulative erosion under conditions of both poor and good rainfall during the critical period. Sorghum and pearl millet tended to produce no yield when erosion exceeded 34 cm and castor bean when it exceeded 40 cm. There was less reduction in yield when rainfall was poor, up to about 10 cm of erosion, than when rainfall was good. These results indicate that pearl millet and castor bean are more suitable than sorghum for low rainfall and eroded conditions. (Author's abstract)
W91-07569

EFFECT OF MIXED ROW CROPPING OF EARLY AND LATE MATURING RICE VARIETIES ON CROP PRODUCTIVITY UNDER INTERMEDIATE DEEPWATER CONDITIONS.
Central Rice Research Inst., Cuttack (India). Agronomy Div.
M. D. Reddy, A. R. Sharma, and M. M. Panda.
Experimental Agriculture EXAGAL, Vol. 27, No. 1, p 79-85, 1991. 1 fig, 4 tab, 7 ref.

Descriptors: *Agricultural practices, *Crop yield, *Cropping, *India, *Plant-water relationships, *Rice, Developing countries, Excess water, Germination, Mixed cropping, Monsoons.

Experiments were conducted in Cuttack, India to examine the feasibility of growing tall early and dwarf late maturing rice varieties in pure and mixed stands in an area where there is normally an excess of water but where the start of the monsoon season is unreliable. Two early maturing semi-tall (120-130 cm) rice varieties, Kalinga-3 (85 days duration) and Banaprabha (95 days duration), were compared in pure and mixed crop stands under intermediate deepwater conditions (15-50 cm) with a modern late maturing (170 days duration) semidwarf (100 cm) variety, CR 1016. Parallel line seeding of CR 1016 and Kalinga-3 or Banaprabha in alternate rows (1:1 ratio) 20 cm apart yielded 19% more grain than a pure crop of 1016 alone. Mixed crop planting in a 1:2 or 2:1 ratio or with reduced inter-row spacing gave no additional yield advantage. Mixed row cropping prevented lodging in early varieties, whereas monocrops of the same varieties were partially lodged and showed some premature seed germination. The better and more stable yields obtained from such mixed cropping could be beneficial to resource poor farmers growing rice in conditions of excess water. (Medina-PTT)
W91-07570

2J. Erosion and Sedimentation

DREDGING ALTERNATIVE STUDY, CUBITS GAP, LOWER MISSISSIPPI RIVER. REPORT I: TABS-1 NUMERICAL MODEL INVESTIGATION.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
For primary bibliographic entry see Field 8B.
W91-07212

CUMBERLAND SOUND AND KINGS BAY PRE-TRIDENT AND BASIC TRIDENT CHANNEL HYDRODYNAMIC AND SEDIMENT TRANSPORT HYBRID MODELING. VOLUME I: MAIN TEXT AND APPENDIXES A, C, AND D.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
For primary bibliographic entry see Field 8B.
W91-07214

DREDGING ALTERNATIVES STUDY, CUBITS GAP, LOWER MISSISSIPPI RIVER. REPORT 2: TABS-2 NUMERICAL MODEL INVESTIGATION.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
For primary bibliographic entry see Field 7C.
W91-07216

HILLSLOPE EROSION AT THE MAXEY FLATS RADIOACTIVE WASTE DISPOSAL SITE, NORTHEASTERN KENTUCKY.
Geological Survey, Louisville, KY. Water Resources Div.
W. P. Carey, M. Lyverse, and C. R. Hupp.
Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4199, 1990. 37p, 11 fig, 11 tab, 20 ref.

Descriptors: *Erosion, *Geomorphology, *Maxey Flats Site, *Radioactive waste disposal, *Slope degradation, *Water pollution sources, Disposal sites, Erosion rates, Kentucky, Radioactive wastes, Weathering.

Maxey Flats, a disposal site for low level radioactive waste, is on a plateau that rises 300 to 400 ft above the surrounding valleys in northeastern Kentucky. Hillslope gradients average 30-40% on three sides of the plateau. The shortest distance from a hillslope to a burial trench is 140 ft on the west side of the site. Rates of hillslope retreat were determined through a combination of direct erosion measurements during the 2-yr study and through dendrogeomorphic techniques. Because the dendrogeomorphic rates are average rates calculated from the last 90 years, they were used to estimate the amount of time required for the hillslopes to retreat into the trenches. Rates of hillslope retreat determined from dendrogeomorphic evidence range from 3.8-9.1 inches/century, so that time to exposure of the trenches ranges from 35,000 to 65,000 years. The minimum estimate of 35,000 years is for the most actively eroding southern slope. Throughout tens of thousands of years, the rate of hillslope retreat is determined more by the occurrence of infrequent extreme events, such as slope failure, than by the continuous processes of slope wash observed in this study. Shallow slope failures were observed on the east and south slopes of the site. Large slope failures form mappable units on the geologic quadrangle containing the study area. These slope failures cause as much erosion in one event as hundreds or even thousands of years of slope wash. Periods of tens of thousands of years are also sufficiently long for signifi-

cant changes in climate and tectonic activity to occur. Rates of erosion observed during this 2-yr study are highly unlikely to be indicative of rates averaged over periods of tens of thousands of years during which many extreme events can occur. Thus, the long-term geomorphic stability of the Maxey Flats disposal site will be highly dependent upon the magnitude and frequency of extreme erosive events and upon trends in climate change and tectonic activity. (Author's abstract)
W91-07239

AREAL VARIATION OF SUSPENDED-SEDIMENT YIELDS WITHIN AND ADJACENT TO THE COAL FIELDS OF THE EASTERN COAL PROVINCE AND THE EASTERN REGION OF THE INTERIOR COAL PROVINCE.
R. E. Hickman.
Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Hydrologic Investigations Atlas HA-717, 1990. 3p, 18 fig, 48 ref.

Descriptors: *Coal mining, *Data collections, *Sediment yield, *Suspended sediments, Illinois, Iowa, Kentucky, Maps, Missouri, Pennsylvania, Runoff, Sediment load, Sediment transport, West Virginia.

Mean annual suspended sediment yields are shown at stations in and around the coal fields of the Eastern Coal Province and the eastern region of the Interior Coal Province. All stations are on smaller basins with areas of 100 to 1,000 sq km or larger basins with areas of 1,000 to 10,000 sq km. Background sediment yields vary from < 25 kg/sq km/yr in the eastern part of the study area to > 300 mg/sq km/yr in the west. Background yields < 25 mg/sq km/yr in the eastern part of the study area approximate yields from undisturbed, forested basins. Background yields of > 200 mg/sq km/yr in western Illinois and adjacent parts of Missouri and Iowa appear to reflect the presence of thick deposits of Loess. Sediment yields > 200 mg/sq km/yr above background in southeastern Pennsylvania and in western Illinois and adjacent Iowa and Missouri reflect a variety of factors. Large yields in southeastern Pennsylvania reflect coal mining and other human activities. The data suggest that the large yields in western Illinois and adjacent Iowa and Missouri are due partly to the thick deposits of loess in this area. Large sediment yields above background in West Virginia and eastern Kentucky reflect coal production and topography. The areas containing stations that have sediment yields > 200 mg/sq km/yr above background correspond to the counties in which mean annual coal production from surface mines is at least 2 million metric tons. Contour mining, used extensively in West Virginia and eastern Kentucky because of the steep slopes, makes large amounts of material available for transport in surface runoff and streamflow. (Lantz-PTT)
W91-07251

PREDICTION TECHNOLOGY FOR SOIL EROSION BY WATER: STATUS AND RESEARCH NEEDS.
Georgia Univ., Athens. Dept. of Agricultural Engineering.
M. A. Nearing, L. J. Lane, E. E. Alberts, and J. M. Laflen.
Soil Science Society of America Journal SSSJD4, Vol. 54, No. 6, p 1702-1711, November/December 1990. 58 ref.

Descriptors: *Prediction, *Soil erosion, *Universal soil loss equation, Climates, Conservation, Deposition, Headcutting, Mathematical models, Rills, Sediment transport, Sensitivity analysis, Sloughing, Soil profiles.

Erosion prediction technology in the USA, Australia, and Europe is proceeding towards the development of process-based simulation models. The emphasis in erosion research on strictly empirically based models, such as the Universal Soil Loss Equation, is declining. With the process-based technologies comes a new array of research needs. In the USA, the USDA Water Erosion Prediction Project (WEPP) has produced a new generation of soil-erosion prediction technology based on fundamentals of hydrologic and erosion science. The development of the new computer-based WEPP erosion model for estimation of rill and interrill erosion required an extensive review and analysis of current knowledge of the science of soil erosion by water. The relative importance of identified research needs were evaluated using a sensitivity analysis of the WEPP model, which identified the more important of the input variables required to execute the model. The review of research needs addresses four general areas: fundamental erosion relationships; soil and plant parameters related to erosion; data bases, user interfaces, and conservation system design; and, erosion model development and analysis. Some key topics for study include (1) describing headcutting and sidewall sloughing in rills, (2) replacing or better describing the concept of sediment-transport capacity and its relationships to detachment and deposition processes, (3) developing theory and data sets to better predict deposition and sediment enrichment on complex slope profiles, and (4) developing criteria for climate selection to obtain long-term average estimates of soil loss. (Brunone-PTT)
W91-07350

SOIL EROSION AND DEPOSITION EVIDENCE IN A SMALL WATERSHED USING FALLOUT CESIUM-137.
Tennessee Valley Authority, Muscle Shoals, AL. Agricultural Research Dept.
J. M. Soileau, B. F. Hajek, and J. T. Touchton.
Soil Science Society of America Journal SSSJD4, Vol. 54, No. 6, p 1712-1719, November/December 1990. 3 fig, 6 tab, 23 ref.

Descriptors: *Alabama, *Cesium radioisotopes, *Deposition, *Fallout, *Soil erosion, *Tracers, *Watersheds, Baseline studies, Forests, Mathematical models, Model studies, Soil profiles, Universal soil loss equation.

Soil measurements of cesium-137, a fallout component of nuclear testing, were made within a 3.8 ha research watershed in the Limestone Valley of northern Alabama. Cesium-137 activity was compared in soil profiles in eroded and depositional landscape positions. Then, soil erosion and deposition calculated by cesium-137 methods was related to erosion estimated by the Universal Soil Loss Equation (USLE) and to sediment discharge measured at the watershed outlet. Triplicate soil profiles were analyzed for cesium-137 activity to a 46 cm depth in cultivated sites representing slightly eroded ridgetop, eroded side-slope, and depositional downslope positions. These data were compared with baseline cesium-137 measurements in undisturbed adjacent woodland. Erosion calculated by cesium-137 activity losses from baseline values were compared with the USLE estimates on slope transects. Mean total cesium-137 activities on baseline, eroded, slightly eroded, and depositional sites were 4860, 1804, 2807, and 5367 Bq/sq m, respectively. Peak cesium-137 activity and depth to zero activity were much greater in depositional than in eroded and slightly eroded sites. Estimated mean annual (1954 to 1987) soil-erosion rates were similar between cesium-137 and USLE for a slope transect with slight erosion (28 and 26 Mg/ha/yr). On eroded side-slopes, cesium-137 estimates of erosion were 27 to 80% higher than the USLE estimates. The USLE estimated losses between 9 and 52 Mg/ha/yr for uplands during 1984 to 1988 cotton production. Sediment losses measured below the downslope depositional area of the small watershed (Gilbert Farm Research Watershed) were only 1 to 4 Mg/ha/yr. This indirect evidence of extensive sediment deposition in a representative small watershed of karst terrain was supported by cesium-137 activity in depositional soil profiles. (Author's abstract)
W91-07351

SIMULATED EROSION AND FERTILIZER EFFECTS ON WINTER WHEAT CROPPING INTERMOUNTAIN DRYLAND AREA.
Agricultural Research Service, Kimberly, ID. Soil and Water Management Research Unit.
T. W. Massee.
Soil Science Society of America Journal SSSJD4, Vol. 54, No. 6, p 1720-1725, November/December 1990. 2 fig, 2 tab, 24 ref.

Descriptors: *Agriculture, *Crop yield, *Fertilizers, *Soil erosion, *Wheat, Available water, Harvesting, Infiltration, Loam, Nutrient concentrations, Precipitation, Seasonal distribution, Silt, Soil treatment, Soil types, Topsoil, Water storage.

Topsoil losses from erosion in the intermountain dry-farming area reduces crop yields. The hypothesis was tested that the effects of erosion on water storage and wheat (Triticum aestivum L.) could be partially alleviated by applying appropriate fertilizers. Two sites were used, one on Rexburg silt loam, a coarse-silty, mixed, frigid Calcic Haploxeroll, and the other on Newdale silt loam, a coarse-silty, mixed, frigid Calciorthidic Haploxeroll. Topsoil-depth treatments were +15, 0, -15, or -30 cm changes relative to the original surface. After making the soil depth changes, 54 kg P/ha were incorporated on one half of each topsoil depth plot and the other half received no P. These P or no P plots were split for applications of 0, 34 or 68 kg N/ha. Phosphorus had no effect on wheat yield. Without fertilizer N, yields on -15 and -30 cm plots were reduced 46 and 55%, respectively, but increased 69% from the addition of 15 cm of topsoil, compared with the 0 cm plot. Removing 15 and 30 cm of topsoil also reduced the upper limit of N-fertilized production to 80 and 65%, respectively, of production on undisturbed N-fertilized plots. Three kilograms fertilizer N/ha each crop year offset each centimeter of soil removed, but only to the new lower production limit. All plots had similar amounts of stored, available soil water in the spring, but a large fraction of this water remained unused at harvest on plots with 15 and 30 cm of topsoil removed because the low-yielding wheat did not use as much water. Profile water differences at harvest were no longer apparent by the next spring, following winter recharge. Unused water at harvest, which partially filled the soil profile, reduced winter infiltration and contributed to subsequent runoff from precipitation on those plots. Adding N fertilizer was only a partial solution to topsoil deficiencies. (Author's abstract)
W91-07352

TILLAGE AND CANOPY COVER EFFECTS ON INTERRILL EROSION FROM FIRST-YEAR ALFALFA.
Wisconsin Univ., Madison. Dept. of Soil Science.
S. J. Sturgul, T. C. Daniel, and D. H. Mueller.
Soil Science Society of America Journal SSSJD4, Vol. 54, No. 6, p 1733-1739, November/December 1990. 6 tab, 38 ref.

Descriptors: *Alfalfa, *Canopy, *Soil erosion, *Surface runoff, *Tillage, *Wisconsin, Crop yield, Moldboard, Plant growth, Seasonal distribution, Simulated rainfall, Statistical analysis.

Alfalfa (Medicago sativa) establishment techniques commonly produce a soil surface susceptible to high runoff and soil losses prior to crop canopy development. Four alfalfa establishment techniques were investigated for runoff, erosion, and forage yield over two growing seasons on a Plano silt loam soil (fine-silty, mixed, mesic Typic Argiudoll) with a 5% slope in south-central Wisconsin. Alfalfa seedbeds were established on cropland previously in no-till (NT) corn (Zea mays). Five simulated rainfalls were applied to moldboard (MB), moldboard-nurse crop(MB/nc), chisel (CH), and NT alfalfa seedbeds. An additional seedbed investigated was no-till with surface residue removed (NT/wo) immediately prior to rainfall simulation. Relative to MB, CH treatments reduced runoff volumes by 23 to 72% and NT treatments reduced volumes 50 to 100%. Soil-loss reductions of 24 to 64% from CH and 71 to 100% from NT relative to MB were observed. Runoff volumes from NT/wo were the largest of all treatments for four of the five rainfall simulations. Soil losses from NT/wo were statistically similar (P = 0.05) to MB for all rainfall simulations. Comparisons of MB to MB/nc runoff volumes did not indicate an influence of canopy cover on runoff. A MB/nc soil loss of 87% less than MB at a rainfall simulation with MB/nc canopy of 93% relative to MB canopy cover of

47% did indicate a canopy effect on soil loss. No significant influence of canopy development on runoff volumes from similar treatments over time was evident. Canopy development contributed to reduced soil losses within all treatments, with a maximum reduction of 96% observed for MB/nc canopy cover of 93% relative to MB/nc soil loss at 0% canopy. Establishment year alfalfa yield and quality did not vary using MB, CH, and NT treatments at a significance level of P = 0.05. (Author's abstract)
W91-07354

INFILTRATION IN ADJACENT CECIL AND PACOLET SOILS.
Georgia Univ., Athens. Dept. of Agronomy.
For primary bibliographic entry see Field 2G.
W91-07355

KHNIFISS LAGOON AND ADJACENT DESERT AREA: GEOGRAPHICAL DESCRIPTION AND RECENT COASTLINE CHANGES.
Institut Scientifique, Rabat (Morocco). Dept. de Zoologie et Ecologie Animale.
For primary bibliographic entry see Field 2L.
W91-07405

MODELLING OF SETTLING AND FLOCCULATION OF FINE SEDIMENTS IN STILL WATER.
National Water Research Inst., Burlington (Ontario). Rivers Research Branch.
B. G. Krishnappan.
Canadian Journal of Civil Engineering CJCEB8, Vol. 17, No. 5, p 763-770, October 1990, 7 fig, 2 tab, 27 ref.

Descriptors: *Advection, *Diffusion, *Mathematical models, *Model studies, *Path of pollutants, *Sediment transport, *Sedimentation, Flocculation, Particle size, Reservoirs, Sedimentation rates, Settling basins, Stagnant water.

The role of fine-grained sediments in the transport of pollutants in rivers, estuaries, and other water bodies has been widely recognized by a number of investigators. A numerical model to predict the settling behavior of fine sediment mixtures in a stagnant water column was developed to consider both the single-grain settling mode and the floc settling mode. The single-grain settling mode was analyzed by solving the unsteady, one-dimensional diffusion-advection equation numerically and the floc settling mode was examined by solving a coagulation equation expressed as a discrete equation in logarithmic radius space considering the differential settling as the only collision mechanism. The model results were compared with the laboratory experimental data of K. Kranck for both modes of sediment settling. The agreement between the model predictions and the experimental data is good. The model can be used as a basis for such practical applications as predicting sedimentation rates in reservoirs and settling basins. (Author's abstract)
W91-07525

INVESTIGATION ON SILT SOURCE OF POYANG LAKE AND RECENT SEDIMENT REGULARITY OF THE LAKE BASIN (IN CHINESE).
Hydrometerological Experiment Station of Poyang Lake, Xingzi (China).
For primary bibliographic entry see Field 2H.
W91-07539

INFLUENCE OF BIODEPOSITION BY FILTER-FEEDING BIVALVES ON THE MIOBENTHIC POPULATIONS OF A MARITIME MARSH (INFLUENCE DE LA BIODEPOSITION DE BIVALVES FILTREURS SUR LESE PEUPLEMENTS MIOBENTHIQUES D'UN MARAIS MARITIME).
Centre de Recherche en Ecologie Marine et Aquaculture, Nieul sur Mer (France).
A. Dinet, J. M. Sornin, A. Sabliere, D. Delmas, and M. Feuillet-Girard.
Cahiers de Biologie Marine CBIMA5, Vol. 31, No. 3, p 307-322, 1990. 7 fig, 15 ref. English summary.

Descriptors: *Benthic fauna, *Bivalves, *France, *Marine sediments, *Particulate matter, *Salt marshes, *Sedimentation, *Wetlands, Ammonium, Bioindicators, Copepods, Interstitial water, Nematodes, Population decline.

The influence of biodeposition by filter-feeding bivalves (Crassostrea gigas and Mytilus edulis) on the evolution of salt-marsh meiobenthic communities of the French Atlantic coast was studied over a 15-month period. Quantitative variations of meiofauna were analyzed monthly and during some phases of the year cycle, at two or three-day intervals. The factors causing faunal variations were determined by principal component analysis among the main physico-chemical factors of the environment, especially those related to the particulate organic matter of sediments. During the study period, it was difficult to determine the subtle effects of biodeposition on meiofauna. Temperature was the principal seasonal factor responsible for the largest quantitative variations observed in the communities. Nematodes and harpacticoid copepods reacted inversely to the massive input of biodeposits. The most significant observation was a population decline most likely due to the strong reduction of the substrate and a rather high content of ammonium in interstitial waters. (Author's abstract)
W91-07560

PROTOZOA ABUNDANCE, GROWTH, AND BACTERIOVORY IN THE WATER COLUMN, ON SEDIMENTING PARTICLES, AND IN THE SEDIMENT OF HALIFAX HARBOR.
Dalhousie Univ., Halifax (Nova Scotia). Dept. of Biology.
J. A. Novitsky.
Canadian Journal of Microbiology CJMIAZ, Vol. 36, No. 12, p 859-863, December 1990. 1 fig, 3 tab, 37 ref. Natural Sciences and Engineering Research Council of Canada Grant A-6548.

Descriptors: *Canada, *Estuarine environment, *Food chains, *Protozoa, *Sedimentation, Bacterial physiology, Flagellates, Food habits, Marine sediments, Population dynamics, Sediment-water interfaces.

The role of protozoan grazing in controlling bacterial populations was examined in four microbial habitats in Halifax Harbor, Canada: the water column, settling particles, the sediment-water interface, and the sediment. Large numbers of protozoans were found in all habitats although most (>56%) were small (<5 micrometers) flagellates. Protozoans larger than 10 micrometers were rarely observed; protozoans >20 micrometers were never observed. Protozoans were also observed to a depth of 9 cm below the sediment surface although efforts to culture viable protozoa failed except for the top 1 cm. The use of the metabolic inhibitor cycloheximide with and without colchicine to selectively inhibit eucaryotic metabolism severely affected procaryotic metabolism in sediment (and presumably particle and water) samples. Using fluorescently labeled bacteria as food, and under optimum conditions, up to 42% of the Protozoa population exhibited active grazing within 7 h. Using protozoan and bacterial community sizes and doubling times, it was calculated that each protozoan in Halifax Harbor would have to consume 13-118 bacteria per hour for the enumerated nanoplanktonic (<20 micrometers) Protozoa to be the sole control of the size of the bacterial community. (Author's abstract)
W91-07563

EFFECT OF CUMULATIVE EROSION AND RAINFALL ON SORGHUM, PEARL MILLET AND CASTOR BEAN YIELDS UNDER DRY FARMING CONDITIONS IN ANDHRA PRADESH, INDIA.
Central Research Inst. for Dryland Agriculture, Hyderabad (India).
For primary bibliographic entry see Field 2I.
W91-07569

SEDIMENT MANAGEMENT WITH SUBMERGED VANES: I. THEORY.
Iowa Univ., Iowa City. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 8B.
W91-07588

SEDIMENT MANAGEMENT WITH SUBMERGED VANES: II. APPLICATIONS.
Iowa Univ., Iowa City. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 8B.
W91-07589

ANALYTICAL SOLUTION FOR DENSITY CURRENTS IN SETTLING BASINS.
Universidade Federal do Parana, Curitiba (Brazil).
For primary bibliographic entry see Field 8B.
W91-07591

RHEOLOGY OF HYPERCONCENTRATIONS.
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8B.
W91-07592

FLUVIAL ARMOR.
Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.
For primary bibliographic entry see Field 8B.
W91-07596

NEW NUMERICAL/PHYSICAL FRAMEWORK FOR MOBILE-BED MODELLING: PART 2--TEST APPLICATIONS.
Iowa Univ., Iowa City.
F. M. Holly, and J.-L. Rahuel.
Journal of Hydraulic Research JHYRAF, Vol. 28, No. 5, p 545-564, 1990. 21 fig, 13 ref. U.S. National Science Foundation Grant MSM-85-166.

Descriptors: *Alluvial channels, *Bed load, *Computer models, *Model studies, *Sediment transport, *Suspended sediments, Computers, Fluvial sediments, Model testing, Reservoirs, Simulation analysis, St Venant equation.

A new computational framework for one-dimensional simulation has been developed. The approach is based on use of the full de St. Venant flow equations, treatment of sediment mixtures, recognition of the distinctly different physics of suspended load and bed load movement, use of a spatial-delay loading law for bed load, and fully-coupled implicit numerical solution of the resulting set of partial-differential equations. In eliminating most of the conceptual and numerical weaknesses of existing methods, the new approach establishes a new standard of fidelity to the governing conservation laws, whatever be the particular empirical sediment relations employed for a particular application. Six different test applications were made: loading-law effects on bed load; fine-material overload in a coarse-bed stream; deposition delta in a reservoir; advection and deposition of suspended material; unsteady reservoir operations; and multiclass dynamics in a variable gradient stream. These tests demonstrated the basic stability and robustness of the new computational method, and demonstrated the ability of the new physical formulation to relieve the user of any need to make a priori declarations of suspended load and bed load classifications. The computational time required for tests using from two to four size classes is about 30 milliseconds per class per point per iteration, on an IBM 4330 mainframe computer. (Fish-PTT)
W91-07597

MECHANISM OF FAILURE OF FRACTURED BLOCK MASSES UNDER THE EFFECT OF A HIGH-VELOCITY FLOW.
For primary bibliographic entry see Field 8B.
W91-07637

RESEARCH NEEDS AND APPLICATIONS TO REDUCE EROSION AND SEDIMENTATION IN TROPICAL STEEPLANDS.
For primary bibliographic entry see Field 4D.
W91-07713

RESEARCH NEEDS AND APPLICATIONS TO REDUCE EROSION AND SEDIMENTATION IN THE TROPICS.
Hawaii Univ., Honolulu.
For primary bibliographic entry see Field 4D.
W91-07714

EROSION AND SEDIMENTATION IN FIJI--AN OVERVIEW.
University of the South Pacific, Suva (Fiji).
R. J. Morrison, W. C. Clarke, N. Buresova, and L. Limalevu.
IN: Research Needs and Applications to Reduce Erosion and Sedimentation in Tropical Steeplands. IAHS Publication No. 192. International Association of Hydrological Sciences, Washington, DC. 1990. p 14-23. 1 fig, 1 tab, 10 ref.

Descriptors: *Erosion, *Fiji, *Land management, *Sedimentation, *Soil erosion, Agriculture, Conservation, Economic aspects, Flooding, Forest management, Land use, Legislation, Logging, Rain forests, Rainfall, Resources management, Topography.

Soil erosion and sedimentation are major problems in Fiji. The steepland topography and highly erosive rainfall contribute to high natural rates of erosion. Over the past 30 to 50 years a substantial area of sloping land has been brought into agricultural production. This extension of agriculture and increased logging of rain forests has caused considerable erosion but there is a lack of quantitative information. The effects of erosion include land degradation and decreased productivity, sediment deposition in rivers with subsequent increase in flooding, and damage to coastal ecosystems by transported sediment. Legislation exists for the control of land use and the encouragement of conservation, but has not been widely applied. The land tenure system, increasing demands for cash income and the lack of strong political commitment to conservation contribute to the continuing problems of soil erosion and sedimentation. (See also W91-07713) (Author's abstract)
W91-07715

EROSION PROBLEMS AND RESEARCH NEEDS OF TROPICAL SOILS.
Chinese Culture Univ., Taipei (Taiwan). Dept. of Natural Resources.
K. F. A. Lo.
IN: Research Needs and Applications to Reduce Erosion and Sedimentation in Tropical Steeplands. IAHS Publication No. 192. International Association of Hydrological Sciences, Washington, DC. 1990. p 24-34. 1 fig, 4 tab, 18 ref.

Descriptors: *Erosion, *Land management, *Soil erosion, *Tropical areas, Agriculture, Cropland, Economic aspects, Flooding, Land use, Population density, Productivity, Rainfall intensity, Research priorities, Resources management, Siltation.

Under natural conditions, tropical soils have moderate to low soil erodibility. When exposed to raindrop impact, these soils slake easily and develop an impermeable crust. As demand for food and energy increases with population, pressures on land use have become so intense that most tropical croplands are losing topsoil at a rate undermining its long-term productivity. Erosion associated problems such as productivity decline, watershed degradation, reservoir siltation and uncontrolled flooding are extensive in the tropics. Baseline research is needed to quantify interrelationships among essential causative parameters, adverse effects on productivity and their modifications, and the importance of land use patterns and cropping systems. More effort is also needed to develop acceptable rates of soil loss in the tropics that will take into account soil productivity, environmental impacts, resource availability, and socioeconomic and cultural issues. (See also W91-07713) (Brunone-PTT)
W91-07716

SEDIMENT DISCHARGE FROM A MONTANE BASIN, PUERTO RICO: IMPLICATIONS OF EROSION PROCESSES AND RATES IN THE HUMID TROPICS.
Geological Survey, Nashville, TN.
A. Simon, and S. Guzman-Rios.
IN: Research Needs and Applications to Reduce Erosion and Sedimentation in Tropical Steeplands. IAHS Publication No. 192. International Association of Hydrological Sciences, Washington, DC. 1990. p 35-47. 4 fig, 4 tab, 24 ref.

Descriptors: *Puerto Rico, *Sediment discharge, *Sediment transport, *Sediment yield, *Soil erosion, *Tropical areas, Forests, Grain size, Mass wasting, Rainfall, Semiarid climates, Temperate zone.

Calculated mean-annual sediment yields for stations upstream of Lago Loiza reservoir, Puerto Rico, range from 1660 tons/sq km/yr to 2880 tons/sq km/yr. These sediment yield data are an order of magnitude greater than maxima reported for the erosive semi-arid regions. Results show that in the high relief basins of eastern Puerto Rico, sediment yields are greater when annual rainfall exceeds 1500 mm, and are as high as 3000 tons/sq km/yr where annual rainfall exceeds 2500 mm. Bed material comprised between 34 and 92% of the total sediment yields. These data are in sharp contrast to data reported from temperate regions, and from other humid tropical areas. The unusually high proportion of bed material in the Lago Loiza basin is attributed to the delivery of coarse-grained saprolitic material to the streams by mass-wasting processes. Although suspended sediment yields from the basin were in general agreement with or exceeded those reported for other humid-tropical basins of high relief, little fine grained material is made available for fluvial transport by overland flow because of dense grass and forest cover and rapid infiltration rates in the coarse-grained saprolite. (See also W91-07713) (Author's abstract)
W91-07717

SOIL AND WATER LOSSES ON PLOTS WITH DIFFERENT LAND USE IN THE PHU WIANG WATERSHED.
Integrated Development of the Phu Wiang Watershed Project Khon Kaen (Thailand).
U. Thongmee, and M. Vannaprasert.
IN: Research Needs and Applications to Reduce Erosion and Sedimentation in Tropical Steeplands. IAHS Publication No. 192. International Association of Hydrological Sciences, Washington, DC. 1990. p 48-52. 1 fig, 4 tab.

Descriptors: *Land use, *Resources management, *Runoff, *Soil erosion, *Thailand, *Watersheds, Agricultural runoff, Agriculture, Field tests, Forests, Statistical analysis.

The runoff and soil loss experimental plots were established by the Royal Forest Department in 1987 on 8% to 10% slope in the forest reserve of the Phu Wiang watershed. Forty-five 4 by 20 m plots were constructed to test three replicates of 15 different land use treatments. The treatments fell into four categories: bare soil, cash crop, cash crop with forest plantation (agroforestry), and forest plantation. Cash crops included two treatments, cassava and peanuts. Agroforestry included eight treatments representing two cash crops combined with two different tree species (Eucalyptus camaldulensis and Leucaena leucocephala) and two different tree spacings (2 by 8 and 4 by 4 m). The forest plantation included four treatments of the two tree species and spacings. The soil loss was maximum on the bare soil, showing a statistically significant difference from the other treatments, and minimum on the forest plantation. The runoff was maximum on the agroforestry treatment, and minimum on the forest plantation, showing a statistically significant difference from the other treatments. (See also W91-07713) (Author's abstract)
W91-07718

EFFECT OF BURNING AND REFORESTATION ON GRASSLAND WATERSHEDS IN THE PHILIPPINES.
Ecosystems Research and Development Bureau, College (Philippines).
A. M. Dano.
IN: Research Needs and Applications to Reduce Erosion and Sedimentation in Tropical Steeplands. IAHS Publication No. 192. International Association of Hydrological Sciences, Washington, DC. 1990. p 53-61. 2 tab, 13 ref.

Descriptors: *Burning, *Erosion, *Grasslands, *Philippines, *Reforestation, *Sediment yield, *Watershed management, Calibrations, Field tests, Land use, Range management, Resources management, Statistical analysis, Suspended sediments, Vegetation, Water yield.

Influence of land use manipulations on two small grassland watersheds was tested using paired watershed treatments in Angat, Bulacan, Philippines. Prior to the implementation of treatments, initial baseline data was collected for four years (1973 to 1976). Catchments were burned during the dry season (in March) to simulate the practice of local ranchers. After calibration, one of the grassed catchments was protected from fire while the other was burned annually. This burned plot served as the control, while the non-burned plot was reforested with Gmelina arborea and observed after 1981. Using covariance and regression analyses, no-burning and reforestation showed increased water yield (9.5% for no-burning, 11% for reforestation) and decreased suspended sediment yield (59% for no-burning and 72% for reforestation) compared with an annually-burned Imperata grassland. A decreasing trend in water yield was observed in the second and successive years after reforestation, suggesting an increasingly consumptive use by the trees as they mature. The increasing protection afforded by constant grass cover and then the presence of trees may have reduced soil erosion, the principal source of suspended sediment. The covariance and regression analyses techniques were sensitive and detected significant changes as a result of land use manipulations and differences in vegetative cover. (See also W91-07713) (Brunone-PTT)
W91-07719

STREAM SUSPENDED SEDIMENT LOAD AFTER CLEAR-FELLING AND DIFFERENT FORESTRY TREATMENTS IN TROPICAL RAINFOREST, SABAH, MALAYSIA.
Sveriges Lantbruksuniversitet, Umea. Dept. of Forest Site Research.
A. Malmer.
IN: Research Needs and Applications to Reduce Erosion and Sedimentation in Tropical Steeplands. IAHS Publication No. 192. International Association of Hydrological Sciences, Washington, DC. 1990. p 62-71. 3 fig, 2 tab, 24 ref.

Descriptors: *Erosion, *Forest management, *Malaysia, *Rain forests, *Sediment erosion, Flow discharge, Logging, Sediment transport, Streams, Suspended sediments, Vegetation, Watersheds.

The effects of different conversions to plantation forests on suspended sediment soil loss were investigated using paired watersheds in a logged-over tropical rainforest in southwest Sabah, Malaysia. Four watersheds were clear-felled: W1 and W2 (having secondary vegetation after forest fires) from which no logs were extracted; W4, where manual extraction was practiced, and; W5, where normal techniques of tractor extraction were used. After felling, the basins were planted with plantation forest trees. At sites W1, W2, and W5, this planting was preceded by burning of the slash. Two catchments were monitored for reference. Suspended sediment loss was determined to be 3.9, 2.1, and 0.9 tons/ha following tractor extraction, manual extraction and no extraction, respectively, for the first 18.5 months during and after extraction. The estimated soil loss by suspended load from the catchments was low before treatments and for control streams. Decomposition of non-burned slash may permit faster runoff during intense rain events because of the lack of ground

cover. Higher discharge velocities may then cause higher erosion of stream banks and topsoil. (See also W91-07713) (Brunone-PTT)
W91-07720

SOIL EROSION IN DRY-HOT VALLEYS OF TROPICS AND SUBTROPICS IN SOUTHWEST CHINA.
S. Liu, B. Tang, J. Li, and X. Shang.
IN: Research Needs and Applications to Reduce Erosion and Sedimentation in Tropical Steeplands. IAHS Publication No. 192. International Association of Hydrological Sciences, Washington, DC. 1990. p 72-83. 1 fig, 1 tab.

Descriptors: *China, *Erosion, *Land management, *Semiarid lands, *Soil conservation, *Soil erosion, *Tropical areas, Economic aspects, Evaporation, Landslides, Resources management, Revegetation, Subtropic zone, Valleys, Water conservation, Water resources management.

Soil erosion is a serious problem in the dry valleys of southwest China, especially in the dry valleys of the Jinsha River Basin and the Minjiang River Basin. Moderate soil erosion occurs in low mountainous and hilly areas; gravitational erosion which is very strong in the rocky mountainous areas is observed as debris flows and landslides. Dry valleys usually have young geomorphological characteristics: steeply graded river bed with upward curves, with many steps and rapids. Dry valleys have dry and variable climates with distinct wet and dry seasons and great regional differences in precipitation. The evaporation rate is three or four times as high as precipitation in the dry valleys, and annual relative humidity is usually 50 to 70%. Debris flow occurrence and activity intensifies environmental degradation of dry valleys. Human economic activities accelerate the formation of dry valleys. Ordinary soil and water losses could be prevented and controlled by revegetation, supplemented by small-scale soil and water conservation efforts. Structural measures can protect mountainous areas from landslide and collapse. (See also W91-07713) (Brunone-PTT)
W91-07721

SOIL EROSION AND SUSPENDED SEDIMENT PRODUCTION IN HONG KONG: DEVELOPMENT OF AN ASSESSMENT STRATEGY.
Hong Kong Univ. Dept. of Geography and Geology.
M. R. Peart.
IN: Research Needs and Applications to Reduce Erosion and Sedimentation in Tropical Steeplands. IAHS Publication No. 192. International Association of Hydrological Sciences, Washington, DC. 1990. p 84-93. 1 fig, 2 tab, 17 ref.

Descriptors: *Erosion, *Hong Kong, *Soil erosion, *Soil management, *Suspended sediments, Catchment areas, Monitoring, Rainfall, Resources management, Runoff, Sediment transport, Sediment yield, Spatial variation.

Erosion is widespread in Hong Kong, affecting both undeveloped and developed terrain. Erosion within water catchment areas may result in sedimentation and loss of storage area within reservoirs. Surface drainage and protection could be used on slopes to reduce erosion. Land erosion products discharging into Victoria Harbour may contribute 45,000 cubic m/yr of material. Processes of erosion may exhibit considerable spatial variation, leading to difficulties with quantification. Expansion of monitoring should concentrate upon the assessment of sediment yield from drainage basins. Rainfall and runoff records can be utilized to determine the length of the monitoring period necessary to determine long-term average sediment yield. Relating on-site erosion to sediment yield at the basin outlet is an important future objective. Any monitoring program should also incorporate sediment quality, as well as quantity. (See also W91-07713) (Brunone-PTT)
W91-07722

PRELIMINARY RESULTS OF THE RRAM PROJECT SOIL LOSS AND EROSION CONTROL TRIALS, RWANDA, 1987-1988.
Tropical Research and Development, Inc., Gainesville, FL.
A. Byers.
IN: Research Needs and Applications to Reduce Erosion and Sedimentation in Tropical Steeplands. IAHS Publication No. 192. International Association of Hydrological Sciences, Washington, DC. 1990. p 94-102. 1 tab, 17 ref.

Descriptors: *Agricultural watersheds, *Erosion control, *Rwanda, *Soil erosion, *Tillage, Contour terracing, Monitoring, Ruhengeri Prefecture, Tropical areas, Watersheds.

First-year runoff plot and hydrological data from the USAID-funded Ruhengeri Resource Analysis and Management (RRAM) Project in the Ruhengeri Prefecture, northwest Rwanda, suggested that soil loss was much higher than previously estimated. Losses of more than 400 tons/ha/yr were recorded for certain cropped plots, but were reduced to an average of 54 tons/ha/yr with the application of biological contours. These results suggested that between-contour treatments, such as mulch, minimum tillage, and contour planting would be necessary to further reduce soil loss to acceptable levels. The experiment supports the hypothesis that projects with practical, applied research components can quickly provide the preliminary results and insights necessary for the immediate implementation and subsequent refinement of better land use practices. Future needs include the development of monitoring programs that are sensitive to donor and governmental funding and constraints and priorities, that are technically capable of fulfilling project needs and supplementing existing tropical watershed data deficiencies. (See also W91-07713) (Author's abstract)
W91-07723

CONSTRUCTION OF SEDIMENT BUDGETS TO ASSESS EROSION IN SHINYANGA REGION, TANZANIA.
Forest Service, Arcadia, CA.
For primary bibliographic entry see Field 4D.
W91-07724

ACCOUNTING FOR THE STOCHASTIC OCCURRENCE OF LANDSLIDES WHEN PREDICTING SEDIMENT YIELDS.
Washington Univ., Seattle. Dept. of Geological Sciences.
L. Benda, and W. Zhang.
IN: Research Needs and Applications to Reduce Erosion and Sedimentation in Tropical Steeplands. IAHS Publication No. 192. International Association of Hydrological Sciences, Washington, DC. 1990. p 115-127. 5 fig, 19 ref.

Descriptors: *Landslides, *Mathematical models, *Model studies, *Sediment yield, *Sedimentation, *Tropical areas, Deforestation, Forests, Prediction, Simulation analysis, Temporal distribution, Time scale, Watersheds.

Landslides may lead to sedimentation of streams and rivers in tropical environments over a period of decades. Hence, stochastic occurrences of landslides are important when predicting sediment yields, particularly in areas undergoing deforestation. A hillslope stability stimulation model was developed based on the application of an infinite slope stability analysis and a groundwater model to a population of synthetic landslide sites. The decline of apparent root cohesion over time due to vegetation removal is included in this model, and the random occurrence of landslides is generated by a rainfall model. This model is used to predict landslides and sediment yields in mature and second-growth forests, and in clearcuts in a basin in Washington state. The model is best suited for large basins with hundreds to thousands of well-defined landslide sites. The hillslope stability simulation model could be used in the development of sediment budgets in tropical environments where landslides contribute significantly to sediment yields. The model may be particularly useful for predicting river and reservoir sedimentation over time scales of decades to centuries. (See also W91-07713) (Brunone-PTT)
W91-07725

REDUCE EROSION AND SEDIMENTATION IN A TROPICAL WATERSHED WITH A SOIL EROSION SIMULATION MODEL.
Hanover Univ. (Germany, F.R.). Inst. fuer Wasserwirtschaft, Hydrologie und Landwirtschaftlichen Wasserbau.
A. Juarez.
IN: Research Needs and Applications to Reduce Erosion and Sedimentation in Tropical Steeplands. IAHS Publication No. 192. International Association of Hydrological Sciences, Washington, DC. 1990. p 147-153. 3 fig, 12 ref.

Descriptors: *Erosion, *Guatemala, *Mathematical models, *Model studies, *Sedimentation, *Soil erosion, *Tropical areas, *Watersheds, Agriculture, Disturbance, Forests, Runoff, Spatial distribution.

Erosional trends in the humid tropics are sometimes dependent on the extent of disturbance by man. Since spatial variations of soil erosion and the evaluation of soil protection strategies must be studied on small watersheds, limited information is one of the greatest problems in tropical areas when planning soil erosion protection measures. A watershed model FGMOD, together with a soil erosion simulation model, can provide information about runoff and sediment concentrations for a small watershed in areas where information exists only for large basins. This system is being applied to the Chixoy River in Guatemala which has a drainage area of about 5500 sq km. Soil erosion in the area has increased due to human activities and because of uncontrolled treefalls. Although data is not yet available, it is believed that this model will be useful for the analysis of a small watershed with agricultural and forested areas. (See also W91-07713) (Brunone-PTT)
W91-07728

RUNOFF PLOTS AND EROSION PHENOMENA ON TROPICAL STEEPLANDS.
Colorado State Univ., Fort Collins.
T. C. Sheng.
IN: Research Needs and Applications to Reduce Erosion and Sedimentation in Tropical Steeplands. IAHS Publication No. 192. International Association of Hydrological Sciences, Washington, DC. 1990. p 154-161. 16 ref.

Descriptors: *El Salvador, *Erosion control, *Field tests, *Jamaica, *Runoff, *Soil erosion, *Thailand, *Tropical areas, *Watershed management, Agriculture, Conservation, Experimental design, Model studies, Prediction, Research priorities, Soil management, Steeplands.

Runoff plots are used in many developing countries for erosion studies. In the past, reports of plot studies concentrated mostly on presenting figures and statistics and less on explaining the background and the applicability of the results. However, to secure useful results, plots need to be carefully designed and maintained, and followed with meaningful analysis and interpretation. To illustrate this theory an analysis of plot design and logic, management needs, and particularly erosion phenomena and their implications for erosion control work based mainly on observations from runoff plots in the steeplands of Jamaica, El Salvador, and Thailand from the early seventies to the mid-eighties was conducted. This analysis provided the basis for planning several soil conservation and watershed projects in terms of estimating erosion rates, effectiveness of conservation measures, and crop potentials on treated lands. International soil conservation societies, research institutions, or other agricultural or environmental bodies should make efforts to investigate their installations, collect, collate, and coordinate their findings, and help synthesize and publish the results. Standardization of plot design and management practices should also be considered in order to avoid mistakes of the past as well as to make comparisons more meaningful. (See also W91-07713) (Brunone-PTT)

W91-07729

IMPACT OF COMMERCIAL LOGGING ON A SMALL RAINFOREST CATCHMENT IN ULU SEGAMA, SABAH, MALAYSIA.
Manchester Univ. (England).
I. Douglas, T. Greer, W. W. Meng, T. Spencer, and W. Sinun.
IN: Research Needs and Applications to Reduce Erosion and Sedimentation in Tropical Steeplands. IAHS Publication No. 192. International Association of Hydrological Sciences, Washington, DC. 1990. p 165-173. 3 fig, 2 tab, 9 ref. Natural Environment Research Council Grant GR 3/6360.

Descriptors: *Borneo, *Catchment areas, *Erosion, *Land use, *Logging, *Malaysia, *Rain forests, *Storm runoff, Headwaters, Rainfall intensity, Road construction, Sediment yield, Water resources management.

Three stages of logging activity in the 0.56 sq km Sungei Steyshen Batu catchment in Borneo produce incremental effects on total suspended sediment yield. Logging road construction across the headwaters of the catchment led to peak suspended sediment concentrations in storm runoff of over 2000 mg/L, more than double previously recorded maxima, but total sediment yields per storm remained below 5 tons. Logging along a strip 36.7 m wide on either side of the road leads to concentrations up to 13,000 mg/L and removal of as much as 11 tons in a single storm. More extensive, mainly high lead logging saw both higher sediment yields and longer duration of high sediment concentrations during storm runoff. The storage of sediment within the catchment makes large, rare storms particularly important in the total sediment budget. The impacts of commercial forestry are felt as a series of increments which lead to the exposure, mobilization, storage and evacuation of sediment from the catchment. Activities which create new sediment sources should be avoided at the times of year when the heaviest rains occur. (See also W91-07713) (Brunone-PTT)
W91-07730

HILLSLOPE EROSION, SEDIMENTATION, AND RELIEF INVERSION IN SE BRAZIL: BANANAL, SP.
Universidade Federal do Rio de Janeiro (Brazil). Dept. de Geografia.
A. L. C. Netto, and N. F. Fernandes.
IN: Research Needs and Applications to Reduce Erosion and Sedimentation in Tropical Steeplands. IAHS Publication No. 192. International Association of Hydrological Sciences, Washington, DC. 1990. p 174-182. 5 fig, 17 ref.

Descriptors: *Brazil, *Geomorphology, *Groundwater movement, *Sedimentation, *Soil erosion, *Storm seepage, Channel morphology, Field tests, Groundwater, Hollows, Landslides, Slopes, Topography.

Hillslope concavities (or hollows) showing highly discontinuous subsurface structures constitute an important site for channel incision by seepage erosion. Field studies were conducted in the Municipio de Bananal in Brazil where landforms are primarily controlled by lithology and rock structure of the underlying Precambrian geologic basement. The current rangeland environment favors the expansion of huge anthills and tunnels. These features control the entry of overland flow into the soil, supporting pipeflow generation and water recharge for the subsurface saturated zones. Channel development occurs mainly in the convergence flow zone along the topographic hollow axis and may trigger slope failures, particularly on steep hillside slopes or headslopes. Adjacent drainage systems with contrasting valley floor elevations would provide conditions for local variations of groundwater level so that incision into the weathered bedrock may contribute to changing the subsurface flow routes due to groundwater piracy. Positive pore pressures may increase at the seepage face to extend slope retreat toward the watershed divides. Such an instability may lead to the destruction of watershed divides and the capture of neighboring channels. More field investigations are needed to understand groundwater flow paths and how relief inversion can affect hillslope and fluvial sedimentation. (See also W91-07713) (Brunone-PTT)
W91-07731

EFFECT OF VEGETATION ON DEBRIS SLIDE OCCURRENCES ON STEEP FORESTED SLOPES IN JAPAN ISLANDS.
Tokyo Univ. of Agriculture and Technology (Japan).
Y. Tsukamoto.
IN: Research Needs and Applications to Reduce Erosion and Sedimentation in Tropical Steeplands. IAHS Publication No. 192. International Association of Hydrological Sciences, Washington, DC. 1990. p 183-191. 6 fig, 5 tab, 7 ref.

Descriptors: *Forests, *Japan, *Landslides, *Vegetation, Elevation, Mathematical models, Model studies, Sea level, Slopes, Soil profiles, Statistical analysis, Tree roots.

The effects of tree roots on debris slides (slip-down of a surface soil mass) were tested on steep forested slopes of Japan. Statistical analysis of factors affecting landslides showed that the vegetation and altitude are the most influential factors. In mountains below 900 m above sea level, vegetation removal is the greatest cause of debris slide occurrence. The transitional slope type is predominant in low relief mountains. The effect of tree roots on slope stability on the transitional slope type was evaluated by a infinite slope model in which the vertical and horizontal roots are expressed with short piles and several layers of nets, respectively. The effect of vertical roots is to compress a potential sliding plane to a lower, harder, soil profile. In Japan, 900 m above sea level seems to be a critical altitude from the viewpoint of vegetation and debris slide occurance. (See also W91-07713) (Author's abstract)
W91-07732

SOIL CONSERVATION ORIENTED LAND SUITABILITY FOR TROPICAL ENVIRONMENTS.
DHV Consultants Ltd., Djakarta (Indonesia).
For primary bibliographic entry see Field 4D.
W91-07734

SOIL EROSION IN EAST KALIMANTAN, INDONESIA.
Mulawarman Univ., Samarinda (Indonesia). Faculty of Forestry.
T. Stadtmueller.
IN: Research Needs and Applications to Reduce Erosion and Sedimentation in Tropical Steeplands. IAHS Publication No. 192. International Association of Hydrological Sciences, Washington, DC. 1990. p 221-230. 1 fig, 3 tab, 26 ref.

Descriptors: *Erosion, *Erosion control, *Indonesia, *Soil conservation, *Soil erosion, *Soil management, Cultivation, Forest fires, Grasslands, Logging, Mining, Political aspects, Productivity, Slopes, Soil fertility, Vegetation.

In East Kalimantan, Indonesia, soil characteristics and the hilly topography favor soil erosion as soon as the vegetative cover is broken. In most areas, if soil conservation is not applied from the moment of breaking new lands, erosion will occur and soil fertility will decrease. Large areas have already deteriorated and are unproductive. The main erosion issues include logging, shifting cultivations, pepper plantations, transmigration, forest fires, alang-alang grasslands, and coal mining. The establishment of environmental and soil conservation programs is necessary in East Kalimantan, which has been seriously damaged. The watershed management approach is strongly recommended for planning and execution of soil conservation programs. In East Kalimantan, the limits of districts and subdistricts often coincide with basin divides, which is a political and administrative advantage for soil conservation programs. (See also W91-07713) (Author's abstract)
W91-07735

TRADITIONAL ADAPTATION TO NATURAL PROCESSES OF EROSION AND SEDIMENTATION ON YAP ISLAND.
Forest Service, Yap, Carolina Islands, TT.
M.C. Falanruw.
IN: Research Needs and Applications to Reduce Erosion and Sedimentation in Tropical Steeplands. IAHS Publication No. 192. International Association of Hydrological Sciences, Washington, DC. 1990. p 231-237. 6 ref.

Descriptors: *Caroline Islands, *Micronesia, *Population dynamics, *Rainfall, *Sedimentation, *Soil erosion, Agriculture, Coasts, Fallowing, Forests, Resources management, Seasonal variation, Siltation, Soil management, Yap.

Yap, in the Western Caroline Islands, is a high island with a mean annual rainfall of 3040 mm and considerable erosion potential. The island once supported a dense population with a nature-intensive technology. The traditional food production system incorporated tree gardens, which mimic natural forests in interception of rainfall and soil retention, and taro patch systems, which mimic swamp forests as silt traps. Trails were stone-paved and were drained by stone-lined ditches. Currently, gardens are alternated with wild forest and bamboo cover. In wild forests, the canopy is removed during the dry season and a mixture of planted crops cover the soil by the time the heavy rains arrive. The system requires an ample fallow period to be sustainable. Systems of ditches are utilized to manage water runoff. In coastal areas, management of stream flow was used in land fill operations. These systems have been successful in preventing erosion and maintaining the soil; however, with increasing populations, new methods for management of erosion and siltation are needed. (See also W91-07713) (Author's abstract)
W91-07736

ASSESSMENT OF LANDSLIDE PROBLEMS AND WATERSHED MANAGEMENT IN TAIWAN.
Council for Agricultural Planning and Development, Taipei (Taiwan). Conservation Div.
For primary bibliographic entry see Field 4D.
W91-07737

ECONOMICS OF SOIL CONSERVATION: THE CASE STUDY OF THE FIJI GINGER INDUSTRY.
Ministry of Primary Industries, Suva (Fiji).
For primary bibliographic entry see Field 4D.
W91-07738

INFLUENCE OF TROPICAL CYCLONES AS SOIL ERODING AND SEDIMENT TRANSPORTING EVENTS. AN EXAMPLE FROM THE PHILIPPINES.
Hydraulics Research Ltd., Wallingford (England).
S. M. White.
IN: Research Needs and Applications to Reduce Erosion and Sedimentation in Tropical Steeplands. IAHS Publication No. 192. International Association of Hydrological Sciences, Washington, DC. 1990. p 259-269. 4 fig, 2 tab, 9 ref.

Descriptors: *Cyclones, *Erosion, *Philippines, *Sediment transport, *Soil erosion, *Storms, *Tropical areas, Environmental aspects, Field tests, Flow rates, Rainfall intensity, Runoff, Sediment yield, Statistical analysis.

During a four year study of rainfall, runoff and sediment yield in the Philippines, it has become apparent that tropical cyclones, which on average occur twice a year in this region, are extreme events in terms of rainfall and discharge. These events erode and transport most sediment; however, data is difficult to collect in the physical environment of the Philippines, especially during such large storms. A lack of data means that all estimates of long-term erosion and sediment yield rates rely on large extrapolations from the monitored data set. Even with limited rainfall and discharge data sets, sensible estimates of long-term erosion and sediment yield are possible. In areas

affected by cyclones, high rainfall events may affect a large proportion of the river basin. Rainfall energy is related to rainfall amount for all events, with cyclones covering the range of rainfall records. Using statistical distributions to represent the amounts of sediment transported by cyclone and non-cyclone flows, and the frequency of cyclone occurrence, estimates of long term sediment yield can be made. By analyzing the cyclones apart from the other discharges, different accuracies can be assigned to the distributions, representing the greater uncertainty related to a small cyclone data set. (See also W91-07713) (Brunone-PTT)
W91-07739

EVALUATION OF SOIL TROPICAL EROSION AT THE CATCHMENT/BASIN SCALE.
Tennessee Univ., Knoxville. Dept. of Geography.
C. Harden.
IN: Research Needs and Applications to Reduce Erosion and Sedimentation in Tropical Steeplands. IAHS Publication No. 192. International Association of Hydrological Sciences, Washington, DC. 1990. p 270-278. 1 fig, 11 ref.

Descriptors: *Catchment areas, *Ecuador, *Erosion, *Runoff, *Soil erosion, *Tropical areas, Extrapolation, Hazard assessment, Heterogeneity, Land use, Topography.

The primary problem encountered in extrapolation of soil erosion rates to the mesoscale is that of spatial heterogeneity. Physical and cultural aspects of tropical landscapes present dimensions of environmental parameters and landscape heterogeneity previously underrepresented in soil erosion studies in temperate environments. A new approach to the problem of extrapolation of soil erosion estimates from point or field scale data to the catchment/basin scale is illustrated by the Rio Ambato drainage, Ecuadorian Andes. The study area is treated as a mosaic of smaller units, known as Erosion Hazard Groups. Individual cells comprising these groups are not necessarily contiguous and represent units of the landscape having the same values of selected erosion-related parameters. The basis of mesoscale soil erosion evaluation is the selection of the cell size. The appropriate size will be a function of the drainage basin. Where the purpose of the work is to compare drainages, however, common denominators of cell size and key environmental parameters must be chosen. Although it has proven convenient for decades to have a standardized runoff plot as the basic unit of soil erosion research, constraints realized in work in tropical environments have underscored the need for different more flexible options for the assessment of erosion rates. This new approach has the advantages of not being tied to one erosion assessment methodology and of providing the framework for a relatively rapid, hence inexpensive assessment of erosion on a broad scale. It may be used for a geomorphic unit of the landscape, such as a catchment, or a political unit, such as a province. (See also W91-07713) (Brunone-PTT)
W91-07740

ACCELERATED EROSION DUE TO CLEAR-CUTTING OF PLANTATION FOREST AND SUBSEQUENT TAUNGYA CULTIVATION IN UPLAND WEST-JAVA, INDONESIA.
Vrije Univ., Amsterdam (Netherlands). Inst. voor Aardwetenschappen.
For primary bibliographic entry see Field 4C.
W91-07741

SURFICIAL PROCESSES IN THE RAINFOREST OF WESTERN AMAZONIA.
Bern Univ. (Switzerland). Geographisches Inst.
H. Elsenbeer, and D. K. Cassel.
IN: Research Needs and Applications to Reduce Erosion and Sedimentation in Tropical Steeplands. IAHS Publication No. 192. International Association of Hydrological Sciences, Washington, DC. 1990. p 289-297. 2 fig, 6 tab, 5 ref.

Descriptors: *Amazon, *Catchment areas, *Geomorphology, *Gullies, *Headwaters, *Rain forests, *Rainfall-runoff relationships, *Rills, *Runoff, *Surficial geology, Hydraulic conductivity, Hydraulic profiles, Land use, Mathematical models, Model studies, Overland flow, Rainfall intensity, Water table.

Abundant rills and gullies in headwater catchments of lowland western Amazonia indicate active surficial processes. A first-order catchment in primary rainforest was instrumented to identify the dominant processes and their environmental controls. Overland flow occurred frequently, mainly in the form of concentrated-flow lines, many of which originate from pipe outlets. These near-surface hydrological processes were a consequence of the interaction between rainfall characteristics and the soil hydraulic conductivity (Ksat)-depth function. A hydraulic discontinuity was found at a shallow depth, corresponding to a decrease in Ksat of about three orders of magnitude. The medians of the maximum rainfall intensities are generally smaller than the surface Ksat, but exceed Ksat below a depth of 0.1 m. Overland flow is generated when a temporary water table perched at the shallow hydraulic discontinuity reaches the surface, and as return flow from soil pipes. Tectonic history, soil, and rainfall characteristics cooperate in this primary rainforest environment to support active surficial processes. Assumptions concerning the activity or inactivity of surficial processes in undisturbed tropical steeplands should be carefully evaluated before changes in land use alone are held responsible for triggering active surficial processes, such as overland flow and erosion. (See also W91-07713) (Brunone-PTT)
W91-07742

PREDICTING EROSION HAZARD AREAS USING DIGITAL TERRAIN ANALYSIS.
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Water and Land Resources.
R. A. Vertessy, C. J. Wilson, D. M. Silburn, R. D. Connolly, and C. A. Ciesiolka.
IN: Research Needs and Applications to Reduce Erosion and Sedimentation in Tropical Steeplands. IAHS Publication No. 192. International Association of Hydrological Sciences, Washington, DC. 1990. p 298-308. 6 fig, 16 ref.

Descriptors: *Erosion, *Erosion hazard, *Geomorphology, *Mathematical models, *Model studies, *Soil erosion, *Terrain analysis, Agriculture, Computer programs, Digital map data, Land management, Resources management, Siltation, Simulation analysis, Soil management, Vegetation.

Soil erosion has a broad range of on-site and off-site effects on land and water resources including loss of agricultural productivity, siltation of water supplies, and degradation of water quality. To overcome these problems, land and water managers around the world are applying a set of mathematical models which can provide results cheaply and promptly. The modeling tools in common use in soil erosion research may be classified according to the scale to which they are applied; the mathematical framework which they adopt; how they represent the area being modeled; and, the predictions they make. These models can be applied to integrated terrain analysis and hydrologic modeling package to problems of erosion in semi-arid tropical pasturelands. The model, known as TOPOG, focusses on describing the complex interrelationships which exist between topography, soils, climate and vegetation. TOPOG is an integrated suite of FORTRAN programs which include digital surface modelling, surface discretization and terrain analyses, and steady-state hydrologic simulation. The calculation of a steady-state erosion hazard index (H) can serve as a powerful diagnostic for land managers concerned with protecting landscapes sensitive to disturbance. Calculation of the index entails consideration of most of the parameters affecting the erosion process, including local and source area topography, soil hydraulic and strength properties, vegetation cover and climatic factors. (See also W91-07713) (Brunone-PTT)
W91-07743

PREDICTION AND PREVENTION OF FOREST LANDING FAILURES IN HIGH-INTENSITY RAINFALL AREAS OF NORTHERN NEW ZEALAND.
Forest Research Inst., Christchurch (New Zealand).
For primary bibliographic entry see Field 4D.
W91-07744

PLANNING SECONDARY ROADS TO REDUCE EROSION AND SEDIMENTATION IN HUMID TROPIC STEEPLANDS.
Oregon State Univ., Corvallis. Dept. of Forest Engineering.
For primary bibliographic entry see Field 4D.
W91-07745

SELECTION OF RIPARIAN BUFFER ZONES IN HUMID TROPICAL STEEPLANDS.
Institute of Tropical Forestry, Rio Piedras, PR.
For primary bibliographic entry see Field 4D.
W91-07746

AGROFORESTRY SYSTEMS TO CONTROL EROSION ON ARABLE TROPICAL STEEPLANDS.
Ohio State Univ., Columbus.
For primary bibliographic entry see Field 4D.
W91-07747

ECOLOGICAL RESTORATION OF LANDSLIDES IN MACAYA BIOSPHERE RESERVE, HAITI.
Florida Univ., Gainesville.
For primary bibliographic entry see Field 4D.
W91-07748

WATERSHED RESTORATION REDUCES RUNOFF AND SEDIMENTATION FROM COMPARATIVE WATERSHEDS IN PAKISTAN'S SUBTROPICAL SCRUB ZONE.
Pakistan Forest Inst., Peshawar.
For primary bibliographic entry see Field 4D.
W91-07751

WATER EROSION AND WATER QUALITY.
Agricultural Research Service, Pullman, WA.
D. K. McCool, and K. G. Renard.
IN: Dryland Agriculture: Strategies for Sustainability. Advances in Soil Science, Volume 13. Springer-Verlag New York, Inc., New York. 1990. p 175-185. 37 ref.

Descriptors: *Agriculture, *Erosion, *Nonpoint sources, *Path of pollutants, *Soil erosion, *Water pollution sources, *Water quality, Cultivation, Eutrophication, Groundwater pollution, Mathematical models, Model studies, Nutrient transport, Pesticides, Runoff, Sediment chemistry, Sediment transport, Sedimentation, Slopes.

Accelerated soil erosion has been a problem since early civilization and remains so today. Population and economic pressures are causing the cultivation of steeper and more easily damaged lands. Water quality has joined soil erosion as a major concern. Eutrophication, a natural process, is accelerated by the enrichment of water by excess nutrients. Pesticides move into surface waters with either runoff or sediment. Subsurface water quality is mainly impacted by mobile nutrients and pesticides, although, through cracks in initially dry soil, those forms normally associated with surface flow can also enter the groundwater. Models exist and are being developed and improved continually to determine the effect of land management decisions. The most widely used empirical model is the Universal Soil Loss Equation (USLE). A revision of the USLE, called the Revised USLE, is being developed, which retains the use of the six factors and predicts hillslope soil loss on an average annual basis. These models will assist planners and policy makers worldwide in setting and meeting erosion and water quality goals. Movement of nutrients and pesticides in surface runoff is modeled by routing the material with the water or sediment as appropriate. Movement of nutrient and pesticides to groundwater is modeled by use of a leach-

ing model coupled to the infiltration component of the main hydrologic model. The concept of a soil loss tolerance was built into erosion work, to account for the association of erosion and cultivation and livestock production. Models must be user-friendly if they are to be used by a wide range of personnel. (See also W91-07752) (Brunone-PTT)
W91-07760

ROLE OF SOIL BIODIVERSITY IN SUSTAINABLE DRYLAND FARMING SYSTEMS.
Agency for International Development, Washington, DC.
For primary bibliographic entry see Field 3F.
W91-07761

ROLE OF ROCK WEATHERING IN THE PHOSPHORUS BUDGET OF TERRESTRIAL WATERSHEDS.
South Carolina Univ., Columbia. Dept. of Geological Sciences.
L. R. Gardner.
Biogeochemistry BIOGEP, Vol. 11, No. 2, p 97-110, November 1990. 1 fig, 3 tab, 34 ref.

Descriptors: *Amazon River, *Geochemistry, *Phosphorus, *Precipitation, *Weathering, Brazil, Geochemical cycles, Liberty Hill, Rio Negro, Silicon, South Carolina, Volumetric analysis, Watersheds.

Residual soils (saprolites) developed on crystalline rocks appear to form by an essentially isovolumetric process (i.e., without dilation or compaction). Isovolumetric geochemical analysis of a suite of saprolite samples developed on a common parent rock can be used to estimate the relative rates of long-term losses of P and Si during weathering. Using the export of dissolved Si in rivers as a weathering index, it is possible to estimate the rate of P release due to chemical weathering by means of the P-Si loss ratio in saprolite. This method was used to evaluate data from three basins where data were available (Liberty Hill, S. C.; Amazon River, Brazil; Rio Negro, Brazil). Results revealed estimated P weathering release rates for Liberty Hill, Amazon River, and Rio Negro to be 163, 457, and 242 moles P/sq km/yr, respectively. These rates were than compared to precipitation inputs of 684, 700, and 630 moles P/sq km/yr, and total river exports of 256, 4490, and 820 moles P/sq km/yr, respectively. Of the three basins studied, the Rio Negro showed a near perfect balance between the input of P via precipitation and chemical weathering and the riverine output of dissolved and suspended P. However, this alternative system for evaluating the mobility of P raised the unsolved problem of the source that supports the atmospheric P input. (Author's abstract)
W91-07835

INFLUENCE OF MICROFORM BED ROUGHNESS ELEMENTS ON FLOW AND SEDIMENT TRANSPORT IN GRAVEL BED RIVERS.
London Univ. (England).
M. A. Hassan, and I. Reid.
Earth Surface Processes and Landforms ESPLDB, Vol. 15, No. 8, p 739-750, December 1990. 7 fig, 2 tab, 40 ref.

Descriptors: *Alluvial channels, *Channel morphology, *Flow characteristics, *Flow resistance, *River beds, *Sediment transport, Bed load, Cluster analysis, Entrainment, Flumes, Pebbles, River flow, Spatial distribution, Streamflow.

Pebble clusters are reported widely as characteristic of gravel river beds and are known to influence the initial entrainment of bedload. A field assessment suggests that their distribution is not ubiquitous, favoring channel bars, but also reveals a tendency towards a preferred streamwise spacing. A series of laboratory flume experiments were conducted to determine the impact of an increasing density of pebble clusters on both flow resistance and bedload while holding other factors constant. Results from the investigation reveal that flow resistance rises to, and falls from, a peak value as the longitudinal spacing of pebble clusters decreases, in a manner similar to that shown for strip roughness, isolated blocks, and simulated ripples and dunes. The experiments also show a strong inverse relationship between bedload flux rates and the flow resistance induced by the concentration of pebble clusters. It is concluded that pebble cluster spacing tends towards an equilibrium that is regulated by a feedback process involving sediment transport rates, and that the spatial concentration of these microforms will adjust to the point where they induce maximum flow resistance. (Author's abstract)
W91-07851

NUMERICAL MODELLING OF SUSPENDED SEDIMENT FLUXES IN ESTUARINE WATERS.
Bradford Univ. (England). Dept. of Civil Engineering and Structural Engineering.
For primary bibliographic entry see Field 2L.
W91-07861

MOVEMENT AND STORAGE OF SEDIMENT IN RIVERS OF THE UNITED STATES AND CANADA.
Geological Survey, Denver, CO.
R. H. Meade, T. R. Yuzyk, and T. J. Day.
The Geology of North America, Vol. O-1--Surface Water Hydrology, 1990. p 255-280, 21 fig, 3 tab, 185 ref.

Descriptors: *Canada, *River sediments, *Sediment transport, *Sedimentation, *United States, Literature review, Sediment yield, Sediments.

Sediment in river systems is of interest to earth and water scientists working at problems that span several time scales. On the longest time scale (100,000,000 to 1,000,000,000 years), sediment is the major form in which material is transferred from continents to oceans, and the rates at which river sediment has been produced in the geologic past are major concerns of those who study long-term geochemical cycling. At somewhat shorter time-scales (1,000,000 to 100,000,000 years), the properties of the existing sedimentary rocks and deposits are the major clues to past hydrologic and geologic conditions. On a more secular time scale, sediment in rivers is of immediate concern as a reflection of soil erosion, as a major design consideration for reservoir sedimentation, river navigation, and other engineering works, as a transporter of various materials (toxic and otherwise) that are adsorbed onto sediment particles in river systems, and as an influence on the habitat of aquatic wildlife. These secular-scale considerations have prompted research and monitoring activities during the past half century that have provided much of the basic knowledge of sediment in the river systems of North America. The construction of large dams and reservoirs for hydropower and irrigation, beginning in the 1920s and 1930s and peaking during the 1950s and 1960s, has led to the accumulation of long records of river sediment discharge from which design and maintenance criteria could be derived. In this literature review, the following aspects of sediment in the river systems of North America are considered: how sediment is moved by rivers, the natural and anthropogenic factors that influence sediment yields, the storage of sediment in river systems at different time scales, the quantities of sediment transported by rivers of the continent, and the principal sites on the continental edges at which river sediment is deposited. (Lantz-PTT)
W91-07917

REGIONAL ANALYSIS OF HYDROLOGICAL VARIABLES IN GREECE.
National Technical Univ., Athens (Greece). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W91-07940

REGIONALIZATION OF FLUVIAL SEDIMENT YIELD IN EMILIA-ROMAGNA (NORTHERN ITALY).
Bologna Univ. (Italy). Ist. di Costruzioni Idrauliche.
M. Ferraresi.
IN: Regionalization in Hydrology. IAHS Publication No. 191. International Association of Hydrological Sciences, Washington, DC. 1990. p 253-260, 3 fig, 1 tab, 10 ref.

Descriptors: *Fluvial sediments, *Italy, *Model studies, *Regional analysis, *Sediment transport, *Sediment yield, Adriatic Sea, Gaging stations, River sediments, Sediment erosion, Suspended sediments, Yield equations.

The paucity of data which particularly troubles the study of erosion and transport phenomena, makes regionalization techniques an indispensable tool for transferring information from gaged to ungaged sites. A methodology has been developed to regionalize the average annual and monthly fluvial sediment yield. The procedure was particularly devised for those design and management processes whose decisions depend on a reliable estimate of long-term sedimentary budgets; the yearly sediment yield is analyzed first and once its accuracy seems reasonably achieved, is disaggregation into shorter time intervals considered. This methodology was applied to 70 ungaged sites along the rivers of Emilia-Romagna (northern Italy), leading to the conclusion that in the last 40 years the suspended sediment yield has undergone a 70-80% generalized decrease. The impact of human activities can be evaluated in a mean reduction by a factor of 4 during the last 40 years; this represents one of the main causes of granular material depletion in river beds and banks and to the receding evolution of the Adriatic shore line. (See also W91-07920) (Fish-PTT)
W91-07946

COMPARATIVE STUDIES OF ESTUARIES BORDERING THE YELLOW SEA (IN CHINESE).
East China Normal Univ., Shanghai.
For primary bibliographic entry see Field 2L.
W91-07986

TRANSVERSE CIRCULATION AND CHANNEL DEFORMATION NEAR TRAINING WALLS OF BRIDGE CROSSINGS.
For primary bibliographic entry see Field 8B.
W91-08036

BROWN SNOW: A LONG-RANGE TRANSPORT EVENT IN THE CANADIAN ARCTIC.
Department of Fisheries and Oceans, Winnipeg (Manitoba). Freshwater Inst.
For primary bibliographic entry see Field 5B.
W91-08102

2K. Chemical Processes

SPECTROPHOTOMETRIC METHODOLOGIES FOR PREDICTING AND STUDYING ENHANCED DEGRADATION.
Missouri Univ.-Columbia. Dept. of Entomology.
For primary bibliographic entry see Field 5B.
W91-07136

TRANSFORMATION KINETICS OF HALOGENATED ALIPHATIC COMPOUNDS UNDER AEROBIC CONDITIONS.
Johns Hopkins Univ., Baltimore, MD. Dept. of Geography and Environmental Engineering.
A. Leeson, and E. J. Bouwer.
IN: Hazardous and Industrial Wastes: Proceedings of the 21st Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1989. p 670-679. 3 fig, 2 tab, 24 ref.

Descriptors: *Bioremediation, *Chemical properties, *Halogenated organic compounds, *Model studies, *Water pollution treatment, Aerobic conditions, Aerobic treatment, Groundwater pollution, Industrial wastes, Kinetics, Methane bacteria, Monod term.

Halogenated aliphatic compounds are widely used for industrial and commercial purposes. After years of production, these compounds have ap-

peared in drinking water supplies and in groundwater, probably as a result of improper usage, disposal or spillage. The ability of an active methanothrophic consortium to transform halogenated aliphatic compounds at trace concentrations was examined. Products resulting from these transformations were identified and kinetic parameters of the reactions were calculated. Once transformation of the halogenated aliphatic compounds was established, the kinetic parameters of the reactions were evaluated. Substrate utilization rates were described by the Monod rate parameters of maximum specific substrate utilization and the Monod half-velocity constant. Independent determination of these constants is difficult; therefore the ratio of the two was used as a fitting parameter in the modeling efforts to obtain the best fit with experimental data. In theory, those compounds that are most structurally similar to methane would be expected to be degraded more rapidly. The modeling results were consistent with the action of methane monoxygenase as a catalyst for the utilization of a single carbon compound since the Monod rate parameter ratio for chloroform and bromodichloromethane was much greater than those for larger chain compounds such as 1,1,1-trichloroethane and dibromochloropropane. In conclusion, it was demonstrated that methanotrophs have the potential to degrade a wide range of halogenated aliphatic compounds in a relatively short period of time. More importantly, the primary halogenated aliphatic compound transformation products were innocuous substances such as carbon dioxide or particulate material. Enhancement of methanotropic activity may prove to be useful as a treatment alternative for control of point-source hazardous waste discharges, for treatment of contaminated landfill leachates, or for in situ aquifer biorestoration. (See also W91-07139) (Mertz-PTT)
W91-07186

ACIDIC PRECIPITATION. VOLUME 4: SOILS, AQUATIC PROCESSES, AND LAKE ACIDIFICATION.
For primary bibliographic entry see Field 5B.
W91-07227

SOIL REACTION AND ACIDIC DEPOSITION.
Colorado State Univ., Fort Collins. Dept. of Agronomy.
For primary bibliographic entry see Field 5B.
W91-07228

ACIDIC SULFATE SOILS.
Department of Agriculture, Bangkok (Thailand). Div. of Soils.
For primary bibliographic entry see Field 5B.
W91-07229

ALUMINUM SPECIATION: METHODOLOGY AND APPLICATIONS.
Savannah River Ecology Lab., Aiken, SC. Div. of Biogeochemistry.
For primary bibliographic entry see Field 5B.
W91-07230

BUFFERING OF PH DEPRESSIONS BY SEDIMENTS IN STREAMS AND LAKES.
Maine Univ., Orono. Dept. of Geological Sciences.
S. A. Norton, J. S. Kahl, A. Henriksen, and R. F. Wright.
IN: Acidic Precipitation. Volume 4: Soils, Aquatic Processes, and Lake Acidification. Advances in Environmental Science. Springer-Verlag, New York. 1990. p 133-157, 11 fig, 5 tab, 53 ref.

Descriptors: *Acid neutralizing capacity, *Acid rain, *Buffering, *Environmental chemistry, *Hydrogen ion concentration, *Lakes, *Streams, Alkalinity, Aluminum, Calcium, Cation exchange, Neutralization, Sulfates, Water quality.

Streams buffer against depressions of streamwater pH by two distinct processes: (1) cation exchange (primarily Ca and Al) provides a short-term reservoir that is fairly easily exhausted. Most of the Ca appears to reside in exchange positions associated with stream vegetation. Considerable Al may also be adsorbed on vegetation; and (2) association with the dissolution of an Al phase, commonly associated with both inorganic and organic substrates. Solubility product calculations imply that solutions may supersaturate with respect to well-crystallized Al phases such as gibbsite. The amount of Al in stream sediment appears to be large for streams that have a long history of acidic groundwater input but that have a pH > 5. The authors suggest that more alkaline and chronically acidic streams lack this neutralization mechanism. Increases in pH are also resisted by a recharging of the depleted exchange surfaces. Low order streams are thus somewhat protected against episodes of acidification until the Al and Ca reservoirs are exhausted. At that time the stream may become chronically acidic. Increases in the rate of production of alkalinity by lake sediments as a consequence of acidic precipitation are dominated by two processes: SO4 reduction and storage within the sediment, and the release of cations, primarily Ca. The paleolimnological record shows that both of these processes increase in lakes that receive increased excess SO4 and that undergo acidification. However, although alkalinity production from sediments may be significant in lakes, increases in production are important to water quality only in lakes with small drainage basins. (See also W91-07227) (Lantz-PTT)
W91-07232

USE OF AN AUTOCALIBRATION TO EVALUATE THE CONSISTENCY OF A DATA-SET IN RELATION TO GEOCHEMICAL MODEL FORMULATIONS.
Waterloopkundig Lab. te Delft (Netherlands).
For primary bibliographic entry see Field 2F.
W91-07272

RELATIONSHIP BETWEEN SUBSTRATE CONCENTRATION AND OXIDATION OF AMMONIUM AND METHANE IN A STRATIFIED WATER COLUMN.
California Univ., Santa Cruz. Inst. of Marine Sciences.
B. B. Ward, and K. A. Kilpatrick.
Continental Shelf Research CSHRDZ, Vol. 10, No. 12, p 1193-1208, December 1990. 8 fig, 1 tab, 39 ref. NSF Grant OCE-8417038 and NASA Contract NAGW-837.

Descriptors: *Ammonium, *Anoxic conditions, *British Columbia, *Fjords, *Methane, *Oxidation, *Saanich Inlet, *Stratification, *Substrates, *Water chemistry, *Water column, Bacterial physiology, Kinetics, Microorganisms, Mixing, Nutrient concentrations, Oxygen, Water depth.

Distributions and oxidation rates of methane and ammonium were investigated during two cruises in Saanich Inlet, British Columbia in late summer. Distribution of inorganic nutrients were related to oxygen distribution, exhibiting large gradients associated with the oxic-anoxic interface. The depth distribution of oxidation rates were also defined by the oxic-anoxic interface: ammonium oxidation occurred at variable rates (up to 120 nM/day) between the photic zone and the oxic-anoxic interface. Methane oxidation occurred throughout the oxic layer and increased near the interface. The possibility of interactions such as inhibition and competition between the two substrates, methane and ammonium, were investigated in kinetic experiments. Ammonium oxidation rate was independent of both ammonium and methane concentrations. Methane oxidation rates were linearly related to methane concentration, both in manipulation experiments, and in relation to ambient methane concentrations. No evidence was found of interaction between methane and ammonium as alternative substrates for methanotropic and ammonium oxidizing populations, which were both present in the environment. In September, a bolus-type mixing event was observed, which introduced oxygenated deep water into the inlet between a wedge of anoxic, methane rich water. This kind of event is probably important in determining the rate of methane loss, due to increased microbial oxidation at the boundaries of the anoxic wedge. (Author's abstract)
W91-07307

FACTORS AFFECTING THE HYDROCHEMISTRY OF A MANGROVE TIDAL CREEK, SEPETIBA BAY, BRAZIL.
Universidade Federal Fluminense, Niteroi (Brazil). Dept. de Geoquimica.
A. R. C. Ovalle, C. E. Rezende, L. D. Lacerta, and C. A. R. Silva.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 31, No. 5, p 639-650, November 1990. 4 fig, 3 tab, 36 ref.

Descriptors: *Brazil, *Interstitial water, *Mangrove swamps, *Sediment chemistry, *Sepetiba Bay, *Tidal rivers, *Water chemistry, *Wetlands, Alkalinity, Comparison studies, Groundwater chemistry, Hydrogen ion concentration, Nitrates, Nutrient transport, Salinity, Spatial distribution, Temporal distribution, Temporal variation, Tides, Trace elements.

The porewater chemistry and spatial and temporal variation of mangrove creek hydrochemistry was investigated in a tidal creek in Sepetiba Bay, Brazil. Except for nitrate porewater, the concentrations of nutrients analyzed were higher than for creek water. Groundwater is a source of silica and phosphate, whereas total alkalinity and ammonium are related to mangrove porewater migration to the creek. Open bay waters contribute chlorine, dissolved oxygen and an elevated pH. The results also suggest that nitrate concentrations are related to nitrification inside the creek. During flood tides, salinity, chlorine, dissolved oxygen and pH increase, whereas total alkalinity decreases. This pattern is reversed at ebb tides. Silica, phosphate, nitrate and ammonium show erratic behavior during the tidal cycle. Tidal dynamics, precipitation events and nitrification inside the creek were identified as major control factors and an estimate of tidal exchanges indicate that the system is in an equilibrium state. (Author's abstract)
W91-07316

QUANTIFYING EXTERNAL AND INTERNAL NITROGEN AND PHOSPHORUS POOLS, AS WELL AS NITROGEN AND PHOSPHORUS SUPPLIED THROUGH REMINERALIZATION, IN COASTAL MARINE PLANKTON BY MEANS OF A DILUTION TECHNIQUE.
Oslo Univ. (Norway). Dept. of Biology.
T. Andersen, A. K. L. Schartau, and E. Paasche.
Marine Ecology Progress Series MESEDT, Vol. 69, No. 1/2, p 67-80, January 10, 1991. 7 fig, 6 tab, 46 ref.

Descriptors: *Algal growth, *Analytical methods, *Coastal waters, *Nitrogen, *Nutrient concentrations, *Phosphorus, *Phytoplankton, *Plant physiology, Cycling nutrients, Field tests, Limiting nutrients, Norway, Oslofjord, Sampling.

A theoretical framework was developed for analyzing Landry and Hassett type dilution assays under more general conditions, where phytoplankton growth might also be nutrient-limited. The theory, which accounts for growth on available internal and external pools as well as on nutrients supplied through remineralization by grazers, was applied to a series of field experiments performed in nutrient-impoverished waters in the Oslofjord, Southern Norway, in summer 1988. Analysis of the experimental results indicates that the phytoplankton had intracellular stores of phosphorus sufficient for several hours of growth in all experiments, while internal stores of nitrogen were undetectable in 4 out of 6 cases. Dissolved nitrogen pools appeared to be of greater importance to the algae as a nutrient reservoir than were dissolved phosphorus pools. Significant nutrient supplies from remineralization were identified on 3 out of 6 occasions, compensating for around half of the estimated grazing losses in each case. The supplies of remineralized nitrogen and phosphorus were closely balanced with respect to the growth demands of the phytoplankton, indicating that the surplus of cellular phosphorus originated from other sources. (Author's abstract)
W91-07322

PREDICTING CATION MOBILITY IN MONTMORILLONITIC MEDIA BASED ON EXCHANGE SELECTIVITIES OF MONTMORILLONITE.
Louisiana State Univ., Baton Rouge. Dept. of Agronomy.
For primary bibliographic entry see Field 2G.
W91-07338

PHOSPHORUS CHEMISTRY AND MINERALOGY IN EXCESSIVELY FERTILIZED SOILS: SOLUBILITY EQUILIBRIA.
Kansas State Univ., Manhattan. Dept. of Agronomy.
For primary bibliographic entry see Field 2G.
W91-07345

SOIL DENITRIFICATION AND NITRIFICATION POTENTIALS DURING THE GROWING SEASON RELATIVE TO TILLAGE.
Agricultural Research Service, Beckley, WV. Appalachian Soil and Water Conservation Research Lab.
For primary bibliographic entry see Field 3F.
W91-07346

SPATIAL VARIATION IN DENITRIFICATION: DEPENDENCY OF ACTIVITY CENTERS ON THE SOIL ENVIRONMENT.
Copenhagen Univ. (Denmark). Inst. of Population Biology.
For primary bibliographic entry see Field 3F.
W91-07347

TEMPORAL PATTERNS OF SOIL DENITRIFICATION: THEIR STABILITY AND CAUSES.
Copenhagen Univ. (Denmark). Inst. of Population Biology.
For primary bibliographic entry see Field 3F.
W91-07348

PHOSPHORUS AND ALUMINUM RELEASE FROM A SPODIC HORIZON MEDIATED BY ORGANIC ACIDS.
ITT Rayonier, Inc., Yulee, FL. Forest Research Center.
For primary bibliographic entry see Field 2G.
W91-07359

DETERMINATION OF URANIUM IN SOLUTION AT THE NG/L LEVEL BY TIME-RESOLVED LASER-INDUCED SPECTROFLUORIMETRY: APPLICATION TO GEOLOGICAL SAMPLES.
CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses (France).
C. Moulin, C. Beaucaire, P. Decambox, and P. Mauchien.
Analytica Chimica Acta ACACAM, Vol. 238, No. 2, p 291-296, November 15, 1990. 4 fig, 2 tab, 26 ref.

Descriptors: *Analytical methods, *Chemical analysis, *Fluorometry, *Geochemistry, *Lasers, *Uranium, *Water analysis, Actinide elements, Alkaline water, Chemical reactions, Chemical reduction, Chlorides, Detection limits, Groundwater chemistry, Pollutant identification, Pyrenees Mountains, Rare earth elements, Reagents, Sampling, Solubility, Sulfides, Thermodynamics.

Time-resolved laser-induced spectrofluorimetry was used for the determination of uranium at the ng/L level in alkaline water with high chloride and sulfide contents in order to obtain a better understanding of uranium mobilization under natural reducing conditions. Fluran, a chelating agent in buffered solution that forms a single fluorescent uranyl species and acts as a strong complexing agent for other metals in solution, was chosen as the optimum medium. The limit of detection was determined to be 1 ng/L, an order of magnitude lower than previous results. Results are presented for several waters from different localities in the Pyrenees. In all instances, although there are very small amounts of uranium in solution, it seems that uranium is controlled in solution by a mineral phase. It is concluded that this method allows the determination of very low uranium concentrations in the environment and permits the validation of thermodynamic data and more precise measurements of uraninite solubility. (Doria-PTT)
W91-07367

SPECTROPHOTOMETRIC DETERMINATION OF URANIUM IN NATURAL WATERS.
Santiago Univ. (Spain). Faculty of Chemistry.
For primary bibliographic entry see Field 5A.
W91-07369

KHNIFISS LAGOON AND ADJACENT WATERS: CHEMISTRY OF THE SURFACE WATERS.
Institut Scientifique, Rabat (Morocco). Dept. de Zoologie et Ecologie Animale.
For primary bibliographic entry see Field 2L.
W91-07407

DISSOLVED ORGANIC CARBON (DOC) IN LAKES.
Kongelige Veterinaer- og Landbohoejskole, Copenhagen (Denmark). Inst. of Microbiology.
For primary bibliographic entry see Field 2H.
W91-07448

PHYSICOCHEMICAL ASPECTS OF CELL ADSORPTION.
Universite de Technologie de Compiegne (France). Dept. of Chemical Engineering.
For primary bibliographic entry see Field 5D.
W91-07455

ACID WATERS IN WALES.
For primary bibliographic entry see Field 5C.
W91-07472

ROLE OF ACIDITY IN THE ECOLOGY OF WELSH LAKES AND STREAMS.
University Coll., Cardiff (Wales). School of Pure and Applied Biology.
For primary bibliographic entry see Field 5C.
W91-07479

ECOTOXICOLOGICAL STUDIES OF ACIDITY IN WELSH STREAMS.
University Coll., Cardiff (Wales). School of Pure and Applied Biology.
For primary bibliographic entry see Field 5C.
W91-07482

WATER QUALITY CHANGES FROM INPUT TO STREAM.
Institute of Terrestrial Ecology, Grange-over-Sands (England). Merlewood Research Station.
For primary bibliographic entry see Field 5B.
W91-07486

EFFECTS OF ACIDIC PRECIPITATION ON SOIL PRODUCTIVITY.
Maine Univ. at Orono. Dept. of Plant and Soil Sciences.
For primary bibliographic entry see Field 5C.
W91-07505

ALUMINUM TOXICITY AND TOLERANCE IN PLANTS.
Alberta Univ., Edmonton. Dept. of Botany.
For primary bibliographic entry see Field 5C.
W91-07512

HISTORY OF ATMOSPHERIC DEPOSITION OF CD, HG, AND PB IN NORTH AMERICA: EVIDENCE FROM LAKE AND PEAT BOG SEDIMENTS.
Maine Univ. at Orono. Dept. of Geological Sciences.
For primary bibliographic entry see Field 5C.
W91-07517

THROUGHFALL CHEMISTRY AND CANOPY PROCESSING MECHANISMS.
Syracuse Univ., NY. Dept. of Civil Engineering.
D. A. Schaefer, and W. A. Reiners.
IN: Acidic Precipitation, Vol. 3: Sources, Deposition, and Canopy Interactions. Advances in Environmental Science. Springer-Verlag New York, Inc., New York. 1990. p 241-284. 11 fig, 4 tab, 220 ref. NSF Grants DEB-7907346 and BSR-8306228., Electric Power Research Institute's Integrated Study Program RP-2621, and U.S. DOE Grant DE-AC05-84OR21400.

Descriptors: *Acid rain, *Acid rain effects, *Acidification, *Air pollution, *Canopy, *Chemical properties, *Chemistry of precipitation, *Environmental effects, *Forests, *Path of pollutants, *Throughfall, Acidity, Coniferous forests, Deciduous forests, Dry deposition, Ion exchange, Model studies, Prediction.

Forest canopies receive chemical inputs from the atmosphere by rainfall, cloud droplet capture, and the accumulation of particles and vapors by dry deposition. These chemical inputs interact with surfaces in the canopy and are released to the forest floor primarily as throughfall (TF). The processes that control the chemistry of TF in forest canopies are examined. The major focus is the inorganic ions in coniferous forest TF, but organic compounds and deciduous canopies are considered in certain topics as well. The review uses two prototype coniferous forests situated in strongly contrasting environments to assess TF chemistry. First a comparison is made between the atmospheric inputs to which these two foresis are exposed; then the processes controlling TF chemistry that occur in forest canopies in general are examined in detail. These processes are then used to predict ion-specific hypothetical TF chemistry patterns, which are compared to short-term sequential samples of the net ionic fluxes in TF in the two forests. A quantitative understanding of chemical fluxes in TF requires examination of the mechanisms of TF processing by forest canopy components. One such mechanism involves interactions between anthropogenic acidity inputs and the forest canopy, which may increase chemical fluxes in TF. The processes that control the inorganic chemistry of coniferous forest TF include atmospheric inputs from dry deposition as well as physical, chemical, and biological processes that occur on forest canopy surfaces. A review of these processes suggests that dry deposition washoff, diffusion, uptake, and cation exchange control TF chemistry. Substantial progress has been made toward the development of a general model of TF chemistry. (See also W91-07513) (Agostine-PTT)
W91-07518

SURVEY OF TRACE ELEMENTS IN AGRICULTURAL RESOURCES OF CHILE: WATERS AND SOILS OF THE ELQUI AND LIMARI VALLEYS, IV REGION (PROSEPECCION DE ELEMENTOS TRAZAS EN RECURSOS AGRICOLAS DE CHILE. AGUAS Y SUELOS DE LOS VALLES DE ELQUI Y LIMARI, IV REGION).
Estacion Experimental La Platina, Santiago (Chile).
For primary bibliographic entry see Field 5B.
W91-07521

DIRECT DETERMINATION OF COMPLEXING CAPACITY OF ORGANIC MATTER DISSOLVED IN HUANGHE ESTUARY WATER BY THE HUANGHE ESTUARY SEDIMENT-ION EXCHANGE METHOD (IN CHINESE).
Ocean Univ. of Qingdao (China).
L. S. Liu, X. B. Zhang, X. L. Wang, and J. K. Ma.
Oceanologia et Limnologia Sinica (Hai Yang Yu Hu Chao) HYHCAG, Vol. 21, No. 3, p 255-266, July 1990, 6 fig, 1 tab, 15 ref. English summary.

Descriptors: *Analytical methods, *Estuaries, *Estuarine sediments, *Huang He River, *Ion exchange, *Metal complexes, *Water chemistry, Copper, Dissolved solids, Organic matter, Particulate matter, Sediment chemistry, Zinc.

A method for calculating the complexing capacity of sea water and river water was derived and applied to the Huanghe (Yellow river) estuary. The method is based on ion-ligand exchange on particulate surfaces and uses both mass balance and the Langmuir isotherm. Two experiments were designed to simplify the calculation. In one experiment, the estuary sediment served as an ion exchange medium, and in the other experiment, the pH was kept as low as possible (for example a pH of 3) to minimize the exchange of organic matter on particle surfaces, so that it could be ignored. The complexing capacity was 0.49 micromoles at a pH of 8, and the log of the stability constants were 8.45 at a pH of 8 and 3.62 at a pH of 3. The complexing capacity of Cu(II) and Zn(II) were 0.49 and 0.17 micromoles. (King-PTT)
W91-07535

STRONTIUM IN RIVERS OF THE BALTIC BASIN.
Stockholm Univ. (Sweden). Dept. of Geology.
R. Lofvendahl, G. Aberg, and P. J. Hamilton.
Aquatic Sciences AQSCEA, Vol. 52, No. 4, p 315-329, 1990. 5 fig, 7 tab, 40 ref. NFR (Swedish Natural Research Council) Grant No. G-GU 4962-104.

Descriptors: *Baltic Sea, *Geochemistry, *Isotopic tracers, *Mixing, *Solute transport, *Strontium, *Water analysis, *Water chemistry, Bedrock, Drainage area, Geologic history, Rivers, Seawater, Stable isotopes.

The rivers in the Baltic Basin drain a mixture of bedrocks ranging from Mesozoic-Paleozoic sediments in the south to Proterozoic-Archean intrusives in the north. The rivers in the sedimentary basin in the south have high concentrations of Sr, ranging from 100-500 mg/L while the Sr-87/Sr-86 ratio is 0.71, which is close to that of seawater. The northern rivers in the Precambrian shield area have low Sr concentrations of 15-50 mg/L with high Sr-87/Sr-86 ratios of about 0.73 (0.721-0.745). The riverine input of dissolved Sr to the brackish Baltic Sea approaches 60 tons/yr, with a weighted mean Sr-87/Sr-86 ratio close to 0.712. Although the sedimentary area in the south supplies only about 43% of the total river discharge, it gives about 88% of the total Sr input. Because of this and the strong regional riverine variation in Sr-87/Sr-86 ratio, Sr and its isotopes seem to be a convenient tool to unveil mixing relations of water masses in the northern Baltic Sea, provided high resolution analyses are applied. For an overall characterization of water mixing in the Baltic Sea, the neodymium isotope system would probably be superior to that of Sr. (Author's abstract)
W91-07553

EFFECT OF LIGHT ON THE RELEASE OF ORGANIC COMPOUNDS BY THE CYANOBACTERIUM OSCILLATORIA RUBESCENS.
Institut National de la Recherche Agronomique, Thonon-les-Bains (France). Station d'Hydrobiologie Lacustre.
For primary bibliographic entry see Field 2H.
W91-07555

ANAEROBIC BIODEGRADATION OF SKELETAL STRUCTURES IN THE MARINE ENVIRONMENT: II. CHEMICAL ASPECTS (BIODEGRADATION ANAEROBIQUE DES STRUCTURES SQUELETTIQUES EN MILIEU MARIN : II. APPROCHE CHIMIQUE).
Liege Univ. (Belgium). Zoology Inst.
A. Simon, M. Poulicek, R. Machiroux, and J. Thorez.
Cahiers de Biologie Marine CBIMA5, Vol. 31, No. 3, p 365-384, 1990. 12 fig, 4 tab, 22 ref. English summary.

Descriptors: *Anaerobic degradation, *Biodegradation, *Calcified skeletons, *Corsica, *Geochemistry, *Marine environment, Echinoderms, Mass spectrometry, Mollusks, Nutrient regeneration, Sediment-water interfaces, Weathering, X-ray diffraction.

An experimental study of anaerobic degradation processes was undertaken in the Calvi Bay, Corsica and in an aquarium. Three types of calcified skeletons were used: isolated prismatic layer of the shell of the bivalve Pinna nobilis, nacreous layer of the shell of the cephalopod Nautilus pompilius and the skeletal plates of the echinoid Sphaerechinus granularis. The materials were embedded in organoclastic sand-filled closed jars retrieved periodically at 1, 3, 6 or 9 months. Through inductively coupled plasma mass spectrometry and X-ray diffraction analysis, protein, chitin and enzymatic activity estimation showed that calcified skeleton biodegradation occurred rapidly in anaerobiosis. Almost as rapid was anoxic weathering. Biodegradation patterns were very different from one type of calcified skeleton to another, due to differences in organic matter distribution. In contrast to classical views, this study showed that anoxic and oxic biodegradation processes were very similar. This indicated that anoxic decomposition processes may be of utmost importance in recycling organic compounds through nutrient regeneration. In biodegradation processes at the water-sediment interface, anoxic biodegradation is a key phenomenon for understanding biogeochemical cycles and also explains to a large extent, the fate of organic matter in sediments. (Author's abstract)
W91-07561

QUANTITATIVE STRUCTURE-ACTIVITY RELATIONSHIPS: NEW TOOLS FOR REMEDIATION OF CONTAMINATED GROUNDWATER.
Vanderbilt Univ., Nashville, TN. Dept. of Environmental and Water Resources Engineering.
For primary bibliographic entry see Field 5G.
W91-07704

HANDBOOK OF CHEMICAL PROPERTY ESTIMATION METHODS: ENVIRONMENTAL BEHAVIOR OF ORGANIC COMPOUNDS.
For primary bibliographic entry see Field 5B.
W91-07767

OCTANOL/WATER PARTITION COEFFICIENT.
Little (Arthur D.), Inc., Cambridge, MA.
W. J. Lyman.
IN: Handbook of Chemical Property Estimation Methods: Environmental Behavior of Organic Compounds. American Chemical Society, Washington, DC. 1990. p 1.1-1.54. 1 fig, 11 tab, 48 ref.

Descriptors: *Octanol/water partition coefficient, *Organic compounds, *Path of pollutants, *Solubility, *Structure-activity relationships, Physical properties, Physicochemical properties, Test procedures.

The octanol/water partition coefficient (Kow) is defined as the ratio of a chemical's concentration in the octanol phase to its concentration in the aqueous phase of a two phase octanol/water system. Kow may be estimated from fragment constants or from other solvent/water partition coefficients (Ksw). When estimating Kow from fragment constants, a knowledge of the chemical structure is required; for structurally complex molecules, it is helpful to have a measured value of Kow for a structurally similar compound. If a measured value of the chemical's partition coefficient between an organic solvent and water (Ksw) is available, Kow can be calculated from linear regression equations that relate log Ksw (for a particular solvent) and low Kow. The method is straightforward, and the calculations are simple. Estimations from fragment constants and from other solvent/water partition coefficients should be given preference over the approach that uses regression equations with solubility which has larger method errors. Approaches that use regression equations with solubility to estimate Kow provide a rough check on Kow if the fragment-constant method is used and the user is unfamiliar with the procedure. Although the more important structural effects are adequately described by the available factors (F values) for most chemicals, the user should keep in mind that some chemicals deviate seriously from the norm. (See also W91-07767) (Geiger-PTT)
W91-07768

SOLUBILITY IN WATER.
Little (Arthur D.), Inc., Cambridge, MA.
W. J. Lyman.
IN: Handbook of Chemical Property Estimation Methods: Environmental Behavior of Organic Compounds. American Chemical Society, Washington, DC. 1990. p 2.1-2.52. 2 fig, 18 tab, 71 ref.

Descriptors: *Organic chemicals, *Path of pollutants, *Physicochemical properties, *Solubility, Molecular structure, Structure-activity relationships, Test procedures.

The solubility of a chemical in water may be defined as the maximum amount of the chemical that will dissolve in pure water at a specified temperature. The aqueous solubility of organic chemicals can be estimated via numerous pathways which include the bioconcentration factor of the compound in aquatic life, heat of fusion, soil/sediment adsorption coefficient, octanol-water partition coefficient parachor, molecular surface area, boiling point, melting point, topological indices, molar volume, activity coefficient in water, infinite dilution activity coefficient in water, and molecular connectivity parameter. Factors influencing solubility include method of measurement, temperature, pH, salinity and presence of dissolved organic matter. Eighteen different regression equations were found that correlate water solubility with the octanol/water partition coefficient for different groups of chemicals. One or more equations should be selected on the basis of chemical class represented, chemical class not well represented, range of values, method errors and bias, and solid state of the chemical at 25 C. The estimation of solubility from structure (method of Irmann) involves drawing the molecular structure, determining the compound type according to x, y and z variables, and substituting these values in an equation to find solubility in gm/gm H2O at 25 C. (See also W91-07767) (Geiger-PTT)
W91-07769

SOLUBILITY IN VARIOUS SOLVENTS.
Little (Arthur D.), Inc., Cambridge, MA.
W. J. Lyman.
IN: Handbook of Chemical Property Estimation Methods: Environmental Behavior of Organic Compounds. American Chemical Society, Washington, DC. 1990. p 3.1-3.29. 6 fig, 6 tab, 38 ref.

Descriptors: *Organic compounds, *Organic solvents, *Path of pollutants, *Solubility, *Structure-activity relationships, Correlation analysis, Graphical methods, Physicochemical properties, Temperature effects, Test procedures.

Methods for estimating the solubility limits in liquid-liquid and solid (solute)-liquid binary (two-chemical) systems are provided which rely on knowledge of the activity coefficient for the solute and/or solvent at one or more points on the phase-temperature composition diagram. Other estimation methods suggested include: correlations with solvent/water partition coefficients, and the use of this coefficient plus the solubility in water; various formulas based upon the use of solubility parameters; and a semiempirical correlation for gases in liquids. Correlations with solvent/water partition coefficients have never been demonstrated and would require a significant amount of work to develop. The use of various formulas based upon the use of solubility parameters is limited to nonpolar systems. While the use of a semiempirical correlation for gases in liquids is valid for polar and nonpolar systems, the accuracy of the method is not high and lengthy calculations are often involved. (See also W91-07767) (Geiger-PTT)
W91-07770

ACID DISSOCIATION CONSTANT.
J. C. Harris, and M. J. Hayes.
IN: Handbook of Chemical Property Estimation Methods: Environmental Behavior of Organic Compounds. American Chemical Society, Washington, DC. 1990. p 6.1-6.28. 10 tab, 12 ref.

Descriptors: *Acid dissociation constants, *Organic compounds, *Path of pollutants, *Physicochem-

ical properties, Acidity, Aromatic compounds, Organic acids, Test procedures.

The extent to which an organic chemical is partitioned among the gaseous, solid, and solution compartments of a given environment is determined by several physical and chemical properties of both the chemical and the environment. Among the chemical properties, acid-base interactions as measured by acid dissociation constants (Ka), exert a major influence on partitioning. Principle procedures for determining Ka are based on the determination of the pH and the concentrations (or ratio of concentrations) of the acid and conjugate base. Dissociation constants are determined by conductance methods, electrometric methods, spectrophotometric methods, magnetic resonance, and measurements of catalytic effects on well-characterized reactions. If the true thermodynamic Ka is sought, activity coefficient corrections must be applied to the measured concentrations of acid and conjugate base. The dissociation constant of an organic acid (or conjugate acid of an organic base) can be estimated by applying a linear free energy relationship which is an empirical correlation between the standard free energies of reaction or activation for two series of reactions, both subjected to the same variations in reactant structures or reaction conditions. The Hammett correlation is most commonly used for estimation of Ka for aromatic acids. Different procedures are applied for substituted benzoic acids and other aromatic acids. The Taft correlation is used to estimate Ka for aliphatic acids. When estimating Ka values, sources of uncertainty arise because of difficulties in selecting an appropriate parent compound, and in use of values for Hammett substituent constants that are obtained from various sources. (See also W91-07767) (Geiger-PTT)
W91-07773

RATE OF HYDROLYSIS.
For primary bibliographic entry see Field 5B.
W91-07774

ACTIVITY COEFFICIENT.
C. F. Grain.
IN: Handbook of Chemical Property Estimation Methods: Environmental Behavior of Organic Compounds. American Chemical Society, Washington, DC. 1990. p 11.1-11.53. 2 fig, 9 tab, 28 ref.

Descriptors: *Activity coefficient, *Organic compounds, *Path of pollutants, *Solubility, Mathematical studies, Organic solvents, Structure-activity relationships.

As applied to solutions, an activity coefficient is a correction factor compensating for non-ideal behavior. Methods of estimating the activity coefficients of components in solution include enthalpic equations such as the two-suffix Margules, the three-suffix Margules, the van Laar, and the four-suffix Margules models, and entropic equations such as the Wilson, NRTL, and the UNIQUAC models. The infinite dilution activity coefficient method of estimating the activity coefficient can be used to estimate solubility limits, octanol-water partition coefficients, and Henry's law constants. It may also be used to estimate the parameters in any two-parameter equation, e.g., the van Laar equation, which will than allow the estimation of the activity coefficient at any composition. Another method which estimates the concentration dependence of the activity coefficient directly uses the UNIQUAC equation combined with group contribution techniques and is called the UNIFAC (UNIQUAC Functional Group Activity Coefficients) method. For the UNIFAC method the average error in the activity coefficient for a number of systems with water was 23.5% and the maximum error was 90%. (See also W91-07767) (Geiger-PTT)
W91-07778

BOILING POINT.
C. E. Rechsteiner.
IN: Handbook of Chemical Property Estimation Methods: Environmental Behavior of Organic Compounds. American Chemical Society, Washington, DC. 1990. p 12.1-12.55. 1 fig, 17 tab, 34 ref.

Descriptors: *Boiling point, *Organic compounds, *Path of pollutants, *Physicochemical properties, *Volatility, Molecular structure, Physical properties, Vapor pressure.

The boiling point is defined as the temperature at which the vapor pressure of a liquid is equal to the pressure of the atmosphere on the liquid. Besides being an indicator for the physical state (liquid vs. gas) of a chemical, the boiling point also provides an indication of its volatility. Estimates of normal boiling points are based on correlations with physical parameters that are influenced by the molecular structures of the compounds. The Meissner method of estimating normal boiling point correlates boiling points with the parachor and the molar refraction of the compound. Adjustment is made for the compound type/class of interest. The Lydersen, Forman, and Thodos method estimates boiling points from the critical temperature and the ratio between the boiling point and the critical temperature. The Miller method estimates boiling points from the boiling point/critical temperature ratio and the critical pressure and critical volume. The Ogata and Tsuchida method estimates boiling points in empirical fashion. The Somayajulu and Palit method correlates boiling points with atomic number sum. The Kinney method correlates boiling point with boiling point number. The Stiel and Thodos method correlates boiling point with the number of carbons in saturated aliphatic hydrocarbons. The normal boiling point can be adjusted to compensate for impurities by applying Raoult's law and to compensate for pressures other than one atmosphere by using the Clausius-Clapeyron equation. (See also W91-07767) (Geiger-PTT)
W91-07779

HEAT OF VAPORIZATION.
C. E. Rechsteiner.
IN: Handbook of Chemical Property Estimation Methods: Environmental Behavior of Organic Compounds. American Chemical Society, Washington, DC. 1990. p 13.1-13.28. 10 tab, 34 ref.

Descriptors: *Enthalpy, *Latent heat, *Organic compounds, *Path of pollutants, *Physical properties, *Thermodynamics, *Vaporization, Evaporation, Heat transfer, Molecular structure, Physicochemical properties, Thermal properties, Vapor pressure.

The heat of vaporization (also called the latent heat of vaporization, heat of evaporation, or enthalpy of vaporization) is the quantity of heat required to convert a unit mass of liquid into a vapor without a rise in temperature, which implies a constant-pressure process. It is a function of temperature and decreases with increasing temperature. Methods for estimating heats of vaporization of organic compounds incorporate some form of the Clapeyron equation which is modified as necessary and then fit to a set of experimental data to determine the best-fit parameters. Four methods based on critical temperature and pressure are recommended for estimating the heat of vaporization at the normal boiling point. Two of these methods, the modified Klein and the Giacalone, are based on the Clapeyron equation; the other two methods, those of Riedel and Chen, were derived empirically. The heat of vaporization may also be estimated from vapor pressure curves for any material as a function of the heat of vaporization and the difference in the compressibility factors for the liquid and the vapor phases. The shape of the vapor pressure curve may also be described by Antoine's relationship. The estimation of the latent heat of vaporization by compound structure uses a series of structural constants similar to the parachor but which is temperature-independent. The Thiesen correlation is frequently used to estimate latent heat of vaporization at temperatures other than the boiling point. (See also W91-07767) (Geiger-PTT)
W91-07780

VAPOR PRESSURE.
For primary bibliographic entry see Field 5B.
W91-07781

VOLATILIZATION FROM WATER.
For primary bibliographic entry see Field 5B.
W91-07782

FLASH POINTS OF PURE SUBSTANCES.
J. H. Hagopian.
IN: Handbook of Chemical Property Estimation Methods: Environmental Behavior of Organic Compounds. American Chemical Society, Washington, DC. 1990. p 18.1-18.14. 4 fig, 2 tab, 20 ref.

Descriptors: *Flash point, *Organic compounds, *Physical properties, *Thermal properties, *Vapor pressure, *Volatility, Fate of pollutants, Mathematical models, Physicochemical properties, Temperature.

The flash point of a substance is the minimum temperature at which it emits sufficient vapor to form an ignitable mixture with air near its surface or within the chamber of a testing apparatus. Affens' method utilizes actual curves of vapor pressure versus temperature together with experimentally derived lower flammability limits to estimate the equilibrium flash points for n-alkanes with 1 to 14 carbon atoms. Using boiling point data, the boiling points versus flash points was plotted to find the line that best fit these points. The Prugh method makes a number of generalizations that permit prediction of the vapor pressure versus temperature curves and lower flammability or explosive limits of organic compounds solely on the basis of their normal boiling points and chemical structures. The definition of equilibrium flash point, together with actual data for 200 chemicals was used to develop a nomograph and a procedure for its use. The nomograph will yield flash points within approximately 20 F of the correct value. The Butler method plots the flash points of pure hydrocarbons (values obtained by means of the Pensky-Martens closed-cup flash point tester) against their respective normal boiling points and then fits a curve through the points to yield an equation for flash point. Flash points of mixtures are also addressed by a number of researchers. (See also W91-07767) (Geiger-PTT)
W91-07785

DENSITIES OF VAPORS, LIQUIDS AND SOLIDS.
L. H. Nelken.
IN: Handbook of Chemical Property Estimation Methods: Environmental Behavior of Organic Compounds. American Chemical Society, Washington, DC. 1990. p 19.1-19.24. 9 tab, 22 ref.

Descriptors: *Density, *Mathematical models, *Organic compounds, *Physicochemical properties, Fate of pollutants, Molecular structure, Physical properties.

The density of a substance is the ratio of its mass to its volume. The property varies not only with molecular weight but also with molecular interaction and structure. In environmental analysis, the primary reason for estimating the density of a substance is to determine whether gases are heavier or lighter than air, or whether liquids and solids will float or sink in water for chemical spill modeling. Vapor density is estimated by use of the ideal gas law. Two methods are recommended to estimate liquid density. The Grain method requires the boiling point of the compound and knowledge of the molecular structure. The average error obtained by this method on a group of about 30 compounds was near 3.4%. The Bhirud method is more rigorous but slightly more accurate; inputs include the acentric factor (or boiling point in the absence of the acentric factor), the critical temperature, and the critical pressure. Solid density can be estimated by a method based upon fragment constants developed by Immirzi and Perini. Only the structure of the chemical is required for this method. The following atoms and ions are included in this method: H, C, O, N, S, F, Cl, Br, I, Na+, K+, Rb+, F, Cl-, Br-, and I-. The densities of hydrated solids and various hydrogen-bonded solids can also be estimated by this approach. (See also W91-07767) (Geiger-PTT)
W91-07786

SURFACE TENSION.
For primary bibliographic entry see Field 5B.
W91-07787

INTERFACIAL TENSION WITH WATER.
C. F. Grain.
IN: Handbook of Chemical Property Estimation Methods: Environmental Behavior of Organic Compounds. American Chemical Society, Washington, DC. 1990. 21.1-21.16. 2 fig, 4 tab, 11 ref.

Descriptors: *Interfaces, *Interfacial tension, *Organic compounds, *Physical properties, *Physicochemical properties, Correlation analysis, Dispersion, Emulsions, Flow resistance, Mathematical models, Surface tension.

The interfacial tension between an organic liquid and water affects such processes as the formation of stable emulsions, the resistance to flow through orifices, and the dispersion of droplets. A measured or estimated value of the interfacial tension may be important when attempting to determine the fate of a chemical of environmental concern or removing a hazardous liquid from an aqueous environment. When two immiscible or partially miscible liquids are brought into contact, the interface thus formed possesses free surface energy. This surface energy is numerically equal to the interfacial tension. Two methods are recommended for estimating the interfacial tension. Method 1 requires as input information the mutual solubilities of the organic liquid and water. Method 2 requires the mutual solubility data and also the surface tensions of the pure components. Method 1 has an average error of 15.4% and a maximum error of 48.5%; method 2 has an average error of 11.8% and a maximum error of 38.6%. Method 1, the simplest method, is based on a correlation between the logarithm of the sum of the solubilities of a mutually saturated liquid with water and the interfacial tension which exists when these phases are in contact. The correlation is strictly valid at 25 C only. The second method is based upon an empirical correlation known as Antonov's rule. (See also W91-07767) (Geiger-PTT)
W91-07788

LIQUID VISCOSITY.
C. F. Grain.
IN: Handbook of Chemical Property Estimation Methods: Environmental Behavior of Organic Compounds. American Chemical Society, Washington, DC. 1990. p 22.1-22.20. 1 fig, 5 tab, 22 ref.

Descriptors: *Flow, *Organic compounds, *Physical properties, *Physicochemical properties, *Shear stress, *Viscosity, Estimating, Fate of pollutants, Mathematical models.

The viscosity of a liquid is a measure of the forces that work against movement or flow when a shearing stress is applied. It has an important bearing on several problems relating to the transfer or movement of bulk quantities of organic liquids. A knowledge of the viscosity is required in formulas relating to the pumpability of a liquid, the rate of flow (e.g., from a tank), or spreading (e.g., on water) of a chemical spill. Three methods are recommended for determining the viscosity of a liquid at temperatures below its normal boiling point. The first method is strictly graphical and requires a knowledge of the viscosity at some temperature. It is based on the exponential relationship between viscosity and temperature. The second method is based on a relationship between temperature and liquid viscosity with correction factors for the length of the alkane chain. A third method for estimating viscosity of a liquid can be considered a variation of method 2 or even an analytical extension of method 1. The third method also relates constants in the mathematical equation to structure of the molecule. The average errors for methods 1, 2, and 3 for estimating the viscosity of 20 organic liquids were 19%, 22%, and 19%, respectively. (See also W91-07767) (Geiger-PTT)
W91-07789

HEAT CAPACITY.
J. D. Birkett.
IN: Handbook of Chemical Property Estimation Methods: Environmental Behavior of Organic Compounds. American Chemical Society, Washington, DC. 1990. p 23.1-23.22. 7 tab, 13 ref.

Descriptors: *Heat storage, *Organic compounds, *Physicochemical properties, *Thermal properties, Fate of pollutants, Mathematical models, Molecular structure.

Heat capacity (C) is defined as the ratio of the heat absorbed by a system to the resulting temperature increase. For gases, two heat capacities may be defined: one is where heat is absorbed with the system held at constant pressure (Cpg), and the other is where heat is absorbed with the system held at constant volume (Cvg). Heat capacities are required for calculating many thermochemical and engineering parameters. The values are obtained either by direct reference to experimental data, which are not always available, or by various empirical estimation methods. Most of the methods are based on structural considerations, such as the contribution of the component bonds and/or functional groups to the total heat capacity of the molecule. Values contributed by these groups are derived from experimentally determined heat capacities of numerous compounds. Heat capacity is a required parameter in models predicting venting rates and the heating and/or cooling of bulk quantities of the chemical under various conditions. For estimating Cpg of gases two methods are recommended. The first method is based on adding the contribution to the heat of each of the component groups within the molecule; values of these contributions have been calculated for 41 common groups. These contributions are given as the coefficients of a polynomial in temperature. This method is easy to use, if the contributions for all groups present are listed; it generally predicts Cpg to within 5% and is often within 2% of measured values. Benson's method, applicable only at 300 K assigns a value to each divalent or polyvalent atom based on the groups or other atoms to which it is bonded. While the method is difficult for large and complex molecules, it gives an estimation within 1% of the observed values. For estimating liquid heat capacity (Cpl), the simplified group method of Johnson and Huang or the more complex method of Chueh and Swanson may be used. The Johnson and Huang method is based on molecular structure and requires the identification of various molecular groups and the summation of their contributions to the overall value of Cpl. Results with this method generally are within 10% of experimental values. The method of Chueh and Swanson is also based on the principle of aggregating group contributions. While somewhat more complicated, it is generally more accurate giving results within 3% of the experimental values. (See also W91-07767) (Geiger-PTT)
W91-07790

THERMAL CONDUCTIVITY.
J. D. Birkett.
IN: Handbook of Chemical Property Estimation Methods: Environmental Behavior of Organic Compounds. American Chemical Society, Washington, DC. 1990. p 24.1-24.9. 3 tab, 12 ref.

Descriptors: *Organic compounds, *Physical properties, *Physicochemical properties, *Temperature gradient, *Thermal conductivity, *Thermal properties, Estimating equations, Evaporation, Mathematical models, Path of pollutants.

Thermal conductivity is defined as the quantity of heat which will traverse a medium of unit thickness and cross-sectional area per unit time under the influence of an applied temperature gradient. The estimation of thermal conductivities of organic liquids is often required for calculating rates of evaporation of large quantities of spilled liquids. The thermal conductivity of organic liquids is generally estimated by means of equations that utilize other known properties of the material and, to a lesser extent, structural considerations. Two methods are frequently employed, depending upon the required accuracy. An equation was developed in which only the reduced temperature, reduced boiling point, and molecular weight are needed. While errors may be as much as + or -20%, this equation may be adequate for many purposes and is rapidly calculated. A more elaborate equation involves structural factors, molar heat of vaporization at normal boiling point, molar liquid heat capacity, liquid density, and entropy terms. Deviations from experimental values using this equation range from a few percent to approximately 25%. (See also W91-07767) (Geiger-PTT)
W91-07791

DIPOLE MOMENT.
L. H. Nelken, and J. D. Birkett.
IN: Handbook of Chemical Property Estimation Methods: Environmental Behavior of Organic Compounds. American Chemical Society, Washington, DC. 1990. p 25.1-25.22. 1 fig, 3 tab, 8 ref.

Descriptors: *Dipole moment, *Molecular structure, *Organic compounds, *Physical properties, *Polarity, *Structure-activity relationships, Aromatic compounds, Computer models, Electrical properties, Error analysis, Mathematical models, Physicochemical properties.

Dipole moments result from electronegativity differences of the atoms within a molecule. Property correlations for polar compounds often require knowledge of the dipole moment. The dipole moment is also used in some pressure-volume-temperature relationships and in some estimation methods for the diffusion coefficients of polar gases. The dipole moment is a fairly significant parameter used to aid in the determination of molecular structure, bond angles, and resonance. The dipole moment is useful in ascertaining the potential for a molecule to interact with its surrounding medium via hydrogen bonding, Van der Waals forces, and dipole-dipole attractions. Dipole moments may be experimentally determined by a number of methods, including microwave spectroscopy, indices of refraction, infrared vibration/rotation spectra, and electron resonance. The most common method is based upon Debye's equation relating the dipole moment to the dielectric constant and temperature. The dipole moment may be calculated with a computer program, CAMSEQ, which performs a variety of calculations related to molecular mechanics and molecular structure. The heart of this program involves the calculation of conformational potential energy for selected molecular conformations until a structure of minimum energy is found. Fishtine developed a fairly easy method for calculating the dipole moment of substituted benzenes, naphthalene derivatives, and heterocyclics containing nitrogen, oxygen, and sulfur. This method entails the addition of vectors lying in the some plane if each substituent dipole moment is assumed to have a vertical component and a horizontal component. The absolute error associated with the Fishtine method was calculated for a sample group of aromatic compounds and was found to be in the 2-30% range. (See also W91-07767) (Geiger-PTT)
W91-07792

INDEX OF REFRACTION.
L. H. Nelken.
IN: Handbook of Chemical Property Estimation Methods: Environmental Behavior of Organic Compounds. American Chemical Society, Washington, DC. 1990. p 26.1-26.21. 7 tab, 16 ref.

Descriptors: *Molecular structure, *Organic compounds, *Physicochemical properties, *Refraction index, *Refractivity, *Structure-activity relationships, Aromatic compounds, Computer programs, Estimating, Fate of pollutants, Light effects, Mathematical models, Pollutant identification.

The index of refraction and molar refraction are indications of the manner in which a molecule interacts with light. The index of refraction is the ratio of the speed of light in a vacuum to the speed of light in the medium The refractive index is measured using a beam of monochromatic light, typically, the yellow light of the sodium D line. Molar refraction is a function of the density of the medium. Molar refraction and refractive indices are often required in confirming the identity and purity of a compound. Determination of molecular

structure and weight is often aided by these parameters. Molar refraction is also used in estimation schemes for critical properties, surface tension, and the solubility parameter. The refractive index is affected by changes in temperature, pressure, and wavelength of radiation. The refractive index increases as pressure increases due to the resulting increase in density. The refractive index decreases as the wavelength increases. Only two types of methods are available for estimating the refractive index or molar refraction. The first of these is additive in nature and relies upon atomic and structural contributions to estimate molar refraction. The density and molecular weight are then required to calculate a value of the refractive index. The error in the molar refraction is usually less than + or -5%, but can be as much as 10% for two specific classes of compounds. The calculated molar refraction for a compound containing conjugated double bonds is always less than the observed value. For polynuclear aromatics, the discrepancy can be large. The calculated molar refraction for furan-type compounds is always greater than the observed value. The other general method for computing molar refraction is also based upon molecular structure but involves the use of a connectivity function which can be correlated with molar refractivity by regression equations which presently exist for alcohols, ethers, amines, halogen-containing saturated compounds, alkanes, substituted alkyl benzenes, and mono-olefinic alkenes. A computer program has been developed for calculating the connectivity function. (See also W91-07767) (Geiger-PTT)
W91-07793

PHYSICAL AND CHEMICAL CHARACTERISTICS OF TOPOGRAPHICALLY AFFECTED AIRFLOW IN AN OPEN BOREHOLE AT YUCCA MOUNTAIN, NEVADA.
Geological Survey, Reston, VA.
D. G. Thorstenson, E. P. Weeks, H. Haas, and J. C. Woodward.
IN: Proceedings of the Topical Meeting on Nuclear Waste Isolation in the Unsaturated Zone, FOCUS '89. Held September 17-21, 1989, Las Vegas, Nevada. American Nuclear Society, Inc., La Grange Park, Illinois. 1990. p 256-270, 6 fig, 4 tab, 25 ref.

Descriptors: *Air circulation, *Boreholes, *Nevada, *Physicochemical properties, *Yucca Mountain, Argon, Atmospheric pressure, Carbon, Carbon dioxide, Flow velocity, Methane, Nitrogen, Oxygen.

Substantial airflow has been observed in two deep boreholes tapping unsaturated fractured tuffs near the crest of Yucca Mountain, Nevada Test Site (NTS), Nevada. The airflow appears to be the result of two primary mechanisms: (1) a barometric component arising from the fact that pressure in the rocks at depth requires some time to equilibrate with that in the atmosphere following an atmospheric barometric change; and (2) a topographically driven circulation arising from density contrasts due to temperature and humidity differences between an air column in the fractured rock, and an equivalent air column in the atmosphere adjacent to the mountain. The interplay between topographic and barometric effects appears adequate to explain circulation observed in summer, but the high velocity nearly continuous air exhaust observed in the winter, particularly at borehole UZ6S, seems to exceed that which can be explained by these two mechanisms. Borehole UZ6S has exhaled approximately 1 million cu m of gas annually during winter months for three successive years. The flow arises from thermal-topographic effects. The average composition of the exhausted gas is: N2=78%, O2=21%, Ar=0.94%, CO2=0.125%, and CH4=0.2 ppmv. In the thirty-month observation period, there has been a net flux to the atmosphere of approximately 20 cu m of liquid water and 1150 kg of carbon. The gas flowing from UZ6S appears to originate in the soil and/or shallow unsaturated zone at Yucca Mountain crest. (Lantz-PTT)
W91-07813

WATER QUALITY OF INTERSTATE STREAMS IN THE SUSQUEHANNA RIVER BASIN MONITORING REPORT NO. 3, WATER YEAR 1989 (OCTOBER 1988-SEPTEMBER 1989).
Susquehanna River Basin Commission, Harrisburg, PA.
For primary bibliographic entry see Field 5B.
W91-07818

CRITICAL EVALUATION OF THE AVAILABLE MEASUREMENTS FOR THE STABLE ISOTOPES OF BORON.
Arizona Univ., Tucson. Dept. of Hydrology and Water Resources.
R. L. Bassett.
Applied Geochemistry APPGEY, Vol. 5, No. 5/6, p 541-554, September/December 1990. 3 fig, 3 tab, 46 ref. American Chemical Society, Petroleum Research Fund PRF 20448-AC2.

Descriptors: *Boron, *Environmental chemistry, *Geochemistry, *Isotope studies, *Water pollution sources, Analytical methods, Boron radioisotopes, Chemical reactions, Groundwater pollution, Industrial wastewater, Literature review, Municipal wastewater, Path of pollutants, Pollutant identification, Seawater.

The movement of Boron through its global geochemical cycle has been of interest for decades. The isotopic fractionation of 11-B/10-B offers the potential for further determining sources and for understanding the processes which partition B as it moves from the terrestrial to the marine environment, or redistributes within the marine cycle. The current study summarizes and evaluates all available published data for the 11-B/10-B ratios in natural materials. The published values were obtained using solid source mass spectrometry and ion exchange extraction methods. The results of the investigation revealed that isotopic values for delta 11-B ranged from -31 ppm for terrestrial rocks to +40 ppm for sea water, thereby indicating a clear distinction between marine and nonmarine sources. Furthermore, the isotope ratios generally formed a narrow cluster of values for specific rock types reflecting the processes of weathering, alteration, and adsorption. An application of this study may be the use of B isotopes in environmental studies. Boron is a contaminant derived from numerous sources such as municipal and industrial waste. The delta -11B in these wastes or processed waters is often significantly different from the delta-11B of the local groundwater, thereby reflecting the delta-11B values of the nearby rocks. This modification by contaminated water can be < 20 ppm different from the delta-11B of the unaffected water, providing a useful tool for delineating the source of contamination and the direction of migration. (Korn-PTT)
W91-07827

BA AND SR DISTRIBUTION AT THE WATER-TABLE: IMPLICATIONS FOR MONITORING GROUND-WATER AT NUCLEAR WASTE REPOSITORY SITES.
Weizmann Inst. of Science, Rehovoth (Israel). Dept. of Isotope Research.
M. Magaritz, I. B. Brenner, and D. Ronen.
Applied Geochemistry APPGEY, Vol. 5, No. 5/6, p 555-562, September/December 1990. 8 fig, 1 tab, 19 ref.

Descriptors: *Aeration zone, *Barium, *Geochemistry, *Groundwater chemistry, *Israel, *Monitoring, *Path of pollutants, *Radioactive waste, Waste disposal, *Saturation zone, *Strontium, *Water table, Aquifers, Chemical reactions, Environmental chemistry, Radioisotopes, Water chemistry.

The unsaturated zone has been suggested as a suitable repository site for nuclear waste. One of the main concerns is the leakage of radionuclides to the aquifer below where, in the event of a leak, the highest concentrations of contaminants will be found close to the water table (i.e., the uppermost saturated part of the aquifer). The distribution of Ba and Sr, as radionuclide analogs is examined in water samples collected from two research wells at the water table region of a phreatic aquifer in Israel. Large variations were observed in Ba, Sr, Cl, and SO4 concentrations in water samples collected at depth intervals of <9 cm below the water table of the aquifer. Further investigation revealed that the Sr and Ba concentrations appeared to be controlled by dissolution of Sr-rich low Mg-calcite, and BaSO4. The transition from saturated to undersaturated conditions with respect to barite occurred within a depth interval of only 50 cm. It had been previously assumed that water chemistry data obtained from a pumping well was representative of groundwater quality in the vicinity of the well. However, the microscale heterogeneity of groundwater demonstrated that samples obtained from pumping wells may not be suitable for either evaluating mineral equilibrium and water-rock interactions in aquifers, or for monitoring the fate of radionuclides in porous media. (Korn-PTT)
W91-07828

HYDROLOGY OF A SPRING COMPLEX, STUDIED BY GEOCHEMICAL TIME-SERIES DATA, ACQUAROSSA, SWITZERLAND.
Weizmann Inst. of Science, Rehovoth (Israel). Geoisotope Group.
For primary bibliographic entry see Field 2F.
W91-07829

SOURCES AND FRACTIONATION PROCESSES INFLUENCING THE ISOTOPIC DISTRIBUTION OF H, O, AND C IN THE LONG VALLEY HYDROTHERMAL SYSTEM, CALIFORNIA, U.S.A.
Geological Survey, Menlo Park, CA.
For primary bibliographic entry see Field 2F.
W91-07830

RADIUM ISOTOPES, ALKALINE EARTH DIAGENESIS, AND AGE DETERMINATION OF TRAVERTINE FROM MAMMOTH HOT SPRINGS, WYOMING, U.S.A.
Argonne National Lab., IL.
N. C. Sturchio.
Applied Geochemistry APPGEY, Vol. 5, No. 5/6, p 631-640, September/December 1990. 6 fig, 4 tab, 37 ref. Department of Energy, Office of Basic Earth Sciences Contract W-31-109-Eng-38.

Descriptors: *Chemical reactions, *Diagenesis, *Environmental chemistry, *Geochemistry, *Hot springs, *Hydrothermal studies, *Isotope studies, *Radium radioisotopes, *Travertine, *Wyoming, Alkaline earth metals, Barium, Calcite, Calcium carbonate, Chemical precipitation, Earth-water interfaces, Equilibrium, Magnesium, Mineralogy, Radium, Strontium, Thermal water.

Travertine deposits may provide a record of the evolutionary history of major hydrothermal systems. In the current study, thermal water, and travertine from active springs, former vents, and drill core from Mammoth Hot Springs, Wyoming, was analyzed for Ra isotopes (226-Ra, 228-Ra), other alkaline earth elements (Mg, Sr, Ba), and mineralogical compositions. Travertine, presently being deposited, contains 3.0-15.3 pCi/g 226Ra, and has a 228-Ra/226-Ra ratio identical to that in thermal water. Travertine precipitates mostly as aragonite and experiences a complete diagenetic transformation to calcite within 9 a (estimated from 228-Ra/226-Ra value of youngest completely calcite travertine). Systematic compositional changes associated with this diagenetic transformation are enrichment of Mg and depletion of Sr, Ba, and Ra. Apparent mineral-water distribution coefficients for Mg, Sr, and Ba in aragonite and calcite are within the range of those determined experimentally, implying near-equilibrium conditions and high water-rock ratios during travertine diagenesis. Impure travertine obtained from a drill hole had a 230-Th/234-U isochron age of 7700+/-440 a. The content of 236-Ra also decreased with depth in the drill hole. The observed 236-Ra vs. depth relation is consistent with continuous deposition of travertine at the Y-10 site from 7700 a BP to near present at a mean rate of approximately 1.0 cm/a, and indicates minimal exchange of Ra between travertine and pore water after the early diagenetic transformation of aragonite to calcite. These data imply

that, under favorable conditions, 226-Ra measurements may be useful in determining ages and deposition rates for other travertines. (Author's abstract)
W91-07832

CARBOXYLIC ACID ANIONS IN FORMATION WATERS, SAN JOAQUIN BASIN AND LOUISIANA GULF COAST, U.S.A.--IMPLICATIONS FOR CLASTIC DIAGENESIS.
Wyoming Univ., Laramie. Enhanced Oil Recovery Inst.
For primary bibliographic entry see Field 2F.
W91-07833

HYDROGEOCHEMISTRY AND STABLE ISOTOPES OF GROUND AND SURFACE WATERS FROM TWO ADJACENT CLOSED BASINS, ATACAMA DESERT, NORTHERN CHILE.
McGill Univ., Montreal (Quebec). Dept. of Geological Science.
For primary bibliographic entry see Field 2F.
W91-07834

ROLE OF ROCK WEATHERING IN THE PHOSPHORUS BUDGET OF TERRESTRIAL WATERSHEDS.
South Carolina Univ., Columbia. Dept. of Geological Sciences.
For primary bibliographic entry see Field 2J.
W91-07835

POREWATER ACID/BASE CHEMISTRY IN NEAR-SHORE REGIONS OF AN ACIDIC LAKE: THE INFLUENCE OF GROUNDWATER INPUTS.
Old Dominion Univ., Norfolk, VA. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2H.
W91-07836

PCDDS IN THE SEDIMENTS ACCUMULATED ABOUT 8120 YEARS AGO FROM JAPANESE COASTAL AREAS.
Ehime Univ., Matsuyama (Japan). Dept. of Environment Conservation.
For primary bibliographic entry see Field 5A.
W91-07837

ADSORPTION AND DESORPTION OF 3,4-DICHLOROANILINE ON SOIL.
Gesellschaft fuer Strahlen- und Umweltforschung m.b.H. Muenchen, Freising-Attaching (Germany, F.R.). Inst. fuer Oekologische Chemie.
For primary bibliographic entry see Field 5B.
W91-07846

EFFECT OF HYDROCHEMICAL FACTORS ON THE DISSOLUTION RATE OF GYPSIFEROUS ROCKS IN FLOWING WATER.
Exeter Univ. (England). Dept. of Geography.
A. Navas.
Earth Surface Processes and Landforms ESPLDB, Vol. 15, No. 8, p 709-715, December 1990. 4 tab, 25 ref.

Descriptors: *Ebro River, *Geochemistry, *Gypsum, *River beds, *Water chemistry, Alabastrine gypsum, Chemical reactions, Conductivity, Dissolution rate, Environmental chemistry, Flow velocity, Regression analysis, River flow, Saturation, Solubility, Spain, Streamflow.

Gypsum is a major contributor to the salinization of surface waters in the Ebro River Basin of northeast Spain. Direct dissolution appears to be the major mechanism by which gypsum is incorporated into surface waters. Fifty-five dissolution trials were carried out with spheres of alabastrine gypsum placed in flowing water. Experimental conditions involved flow velocities between 0.3 and 1.2 m/sec, electrical conductivities between 0.3 and 1.9 dS/m, and the saturation indices of gypsum between -2.1 and -0.33. Mean values of dissolution rate varied from 104 to 226 g/sq m/hr. This loss of mass corresponded to a volume of gypsum of between 393 and 853 mm/sq m/yr. The relative effects of flow velocity, electrical conductivity, and saturation level were determined using multiple regressions equations. As shown by analysis of variance, it was concluded that the dissolution rate of gypsum was substantially affected by: flow velocity > electrical conductivity > the saturation level of gypsum (which can restrict gypsum solubility). Other factors influencing this process, although to a lesser extent, are the texture of the gypsiferous rock and the saturation levels of calcite and dolomite in the water (i.e., the common ion effect). (Korn-PTT)
W91-07850

EXPERIMENTAL EXAMINATION ON NITROUS OXIDE ACCUMULATION DURING NITRIFICATION IN A FRESHWATER LAKE.
Nagoya Univ. (Japan). Water Research Inst.
For primary bibliographic entry see Field 2H.
W91-07869

GEOCHEMICAL STUDIES ON THE COASTAL LAKES OF KAMIKOSHIKI ISLAND IN KAGOSHIMA PREFECTURE, JAPAN: I. A PRELIMINARY REPORT.
Tokyo Metropolitan Univ. (Japan). Dept. of Chemistry.
For primary bibliographic entry see Field 2H.
W91-07870

DISSOLVED ORGANIC MANGANESE IN THE INTERSTITIAL WATER OF LAKE FUKAMI-IKE.
Nagoya Women's Univ. (Japan). Faculty of Home Economics.
For primary bibliographic entry see Field 2H.
W91-07871

GROUNDWATER QUALITY IN THE TERTIARY LEDO-PANISELIAN AQUIFER IN BELGIUM AS A RESULT OF FRESH-WATER INTRUSION INTO SEDIMENTS IN CHEMICAL EQUILIBRIUM WITH THE SEA.
Ghent Rijksuniversiteit (Belgium). Lab. for Applied Geology and Hydrogeology.
K. Walraevens, and L. Lebbe.
IN: Proceedings of 10th Salt-Water Intrusion Meeting. Geologisch Instituut R.U.G. (S 8), Ghent. 1989. p 30-44, 11 fig, 3 tab, 4 ref.

Descriptors: *Belgium, *Coastal aquifers, *Groundwater chemistry, *Groundwater quality, *Saline water intrusion, *Saline-freshwater interfaces, Cation exchange, Clay minerals, Groundwater movement, Interstitial water.

The present distribution of the groundwater quality in the semi-confined Ledo-Paniselian aquifer (Belgium) is the result of the marine conditions prevailing in the sediments before the last regression. These marine conditions, evident in a marine pore solution and in a marine-cations adsorption on the clay-mineral surfaces, are being gradually expelled by infiltrating freshwater. First the marine pore solution has been diluted and then cation exchange started between the freshwater and the clay particles. In the course of time groundwaters of successively different qualities were thus leaking out from the overlying Bartonian clay into the Ledo-Paniselian aquifer. The resulting groundwater types are found in consecutive zones in the aquifer. The hydrochemistry of these different zones has been classified, allowing for examination of the different processes taking place in the clay layers during the expulsion of marine features. The distribution of the different groundwater types in the Ledo-Paniselian aquifer may be correlated with the calculated natural groundwater flow. Thus far, this distribution, surveyed on a regional scale, is not influenced by the heavy pumpings of the last years, which have changed the groundwater direction and velocity completely. (See also W91-07947) (Author's abstract)
W91-07949

HYDROCHEMICAL STUDY OF A CROSS-SECTION THROUGH THE COASTAL PLAIN AND ITS SURROUNDINGS NEAR THE FRENCH-BELGIAN BORDER.
Ghent Rijksuniversiteit (Belgium). Lab. for Applied Geology and Hydrogeology.
L. Lebbe, and K. Walraevens.
IN: Proceedings of 10th Salt-Water Intrusion Meeting. Geologisch Instituut R.U.G. (S 8), Ghent. 1989. p 56-64, 3 fig, 14 ref.

Descriptors: *Belgium, *Coastal aquifers, *Geohydrology, *Groundwater chemistry, *Groundwater movement, *Saline water intrusion, Brackish water, Dunes, Freshwater, Groundwater quality, Paleohydrology, Polders, Saline-freshwater interfaces, Sea level.

During the period 1974-1984 several hydrogeological studies were carried out in the Belgian coastal plain near the French border. In this area 127 groundwater samples were taken from the phreatic aquifer, and subjected to a total chemical analysis. It was concluded that the groundwater quality distribution beneath the shore and the young dune ridge has mainly been induced by the present topography and the actual sea level: the flow in the freshwater pocket under the dunes is extended into the freshwater tongue beneath the shore, where the semi-diurnal sea level fluctuations give rise to the saltwater lens. The groundwater in the lower part of the aquifer under the young dune ridge is still showing evidence of former saline conditions. The groundwater quality in the remaining part of the surveyed profile is considerably influenced by the much earlier situation, when the piezometric level in the De Moeren lake was higher than the one in the polders. The salt, and later brackish-salt-lake water, that infiltrated in the lake in a deep flow cycle towards the polders, is still found back in the lower part of the aquifer under the polders, and in the main part of the aquifer underneath De Moeren. As the piezometric level in De Moeren after reclamation became lower than the one in the polders, the deep flow cycle was reversed: groundwater is now flowing towards De Moeren, back to where it came from. Brackish-salt-water seepage is resulting in the northern part of De Moeren. As formerly salt lake water infiltrated first, being followed by less saline water, the groundwater seeping out now in De Moeren upon flow reversal, is gradually becoming more saline. The flow reversal is clearly observed in the groundwater chemistry. The deep flow cycle is occurring below the freshwater pocket of the old dunes, and the shallow freshwater infiltration in the polders. In the southern part of De Moeren, the former brackish-salt lake water is present as more or less immobile groundwater. (See also W91-07947) (Fish-PTT)
W91-07951

TOOLS FOR INVESTIGATING THE ORIGIN OF ANOMALIES IN CHLORIDE CONTENT OF GROUNDWATER IN COASTAL LOWLANDS.
Institute of Applied Geoscience TNO, Delft (Netherlands).
For primary bibliographic entry see Field 2F.
W91-07972

SOME PROCESSES IN THE SEA-WATER/FRESH-WATER INTERFACE, AS INFLUENCED BY THE PRESENCE OF GASES.
Calgary Univ. (Alberta). Dept. of Geology and Geophysics.
For primary bibliographic entry see Field 2F.
W91-07973

CHEMICAL AND ISOTOPICAL METHODOLOGIES IN THE STUDIES ON ORIGIN AND EVOLUTION OF GROUNDWATERS FLOWING IN THE COASTAL CARBONATE AND KARST AQUIFER OF APULIA (SOUTHERN ITALY).
Palermo Univ. (Italy). Ist. di Mineralogia.
For primary bibliographic entry see Field 2F.
W91-07976

SEPARATION OF WATER SAMPLES INTO SESTON AND WATER FOR THE DETERMI-

NATION OF ORGANIC POLLUTANTS (TRENNUNG VON WASSER IN SCHWEBSTOFFE UND WASSER ZUR BESTIMMUNG ORGANISCHER SPURENSTOFFE IN OBERFLAECHENGEWAESSERN).
GKSS - Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.).
For primary bibliographic entry see Field 5A.
W91-07988

GAS-CHROMATOGRAPHIC DETERMINATION OF SUBSTITUTED ANILINES IN WATER AFTER SOLID-PHASE EXTRACTION (BESTIMMUNG VON SUBSTITUIERTEN ANILINEN IN WASSER DURCH GASCHROMATOGRAPHIE NACH FESTPHASENEXTRAKTION).
Muenster Univ. (Germany, F.R.). Inst. fuer Lebensmittelchemie.
For primary bibliographic entry see Field 5A.
W91-07989

INTER-ELEMENT INTERFERENCE STUDIES IN THE DETERMINATION OF TRACE AMOUNTS OF PLUTONIUM BY INDUCTIVELY COUPLED PLASMA-ATOMIC EMISSION SPECTROMETRY.
Bhabha Atomic Research Centre, Bombay (India). Radiochemistry Div.
For primary bibliographic entry see Field 5A.
W91-07996

CHEMOMETRIC COMPARISON OF POLYCHLORINATED BIPHENYL RESIDUES AND TOXICOLOGICALLY ACTIVE POLYCHLORINATED BIPHENYL CONGENERS IN THE EGGS OF FORSTER'S TERNS (STERNA FORSTERI).
Fish and Wildlife Service, Columbia, MO.
For primary bibliographic entry see Field 5A.
W91-08000

MOLECULAR CHARACTERIZATION OF TOTAL ORGANIC MATTER AND CARBOHYDRATES IN PEAT SAMPLES FROM A CYPRESS SWAMP BY PYROLYSIS-MASS SPECTROMETRY AND WET-CHEMICAL METHODS.
Technische Hogeschool Delft (Netherlands). Vakgroep Microgolftechniek.
For primary bibliographic entry see Field 2H.
W91-08013

CHLORINATED AND METHYLATED DIBENZOTHIOPHENES: PREPARATION OF THE MODEL COMPOUNDS AND THEIR ANALYSIS FROM SOME ENVIRONMENTAL SAMPLES.
Jyvaeskylae Univ. (Finland). Dept. of Chemistry.
For primary bibliographic entry see Field 5A.
W91-08017

STRUCTURAL AND BEHAVIORAL CHARACTERISTICS OF A COMMERCIAL HUMIC ACID AND NATURAL DISSOLVED AQUATIC ORGANIC MATTER.
Connecticut Univ., Storrs. Dept. of Civil Engineering.
D. Grasso, Y. P. Chin, and W. J. Weber.
Chemosphere CMSHAF, Vol. 21, No. 10/11, p 1181-1197, 1990. 4 fig, 2 tab, 40 ref. National Oceanic and Atmospheric Administration Grant NA86-AA-O-SG403.

Descriptors: *Chemical analysis, *Dissolved organic matter, *Humic acids, *Laboratory methods, *Water chemistry, Chromatography, Geochemistry, Natural waters, Nuclear magnetic resonance.

Dissolved organic matter (DOM) from two natural sources and a commercial humic acid were analyzed using gel permeation chromatography, high pressure reverse phase liquid chromatography, and (H-1)NMR spectroscopy. Results from the chromatographic studies showed that the DOM of two natural waters consisted primarily of relatively low molecular weight, polar organic constituents, while large and relatively nonpolar macromolecules comprised a significant fraction of the commercial humic acid. The NMR assays indicated that DOM from the two natural water samples consisted of nonaromatic organic constituents, while the commercial humic acids tested contained both aromatic and aliphatic moieties. Based upon these composite results of the several different types of analysis employed, it is evident that the humic acid examined, and possibly others prepared in the same way, contain molecular structures which exhibit physical and chemical properties that do not reflect the true nature of DOM in real aquatic systems. Commercially available humic substances of this type may therefore not be suitable surrogates for naturally occurring DOM in laboratory investigations and analysis of geochemical and environmental transformation reactions. (Author's abstract)
W91-08018

SCAVENGING OF SO2 BY CLOUD AND RAIN DROPS: IV. A WIND TUNNEL AND THEORETICAL STUDY OF THE ABSORPTION OF SO2 IN THE PPB(V) RANGE BY WATER DROPS IN THE PRESENCE OF H2O2.
Mainz Univ. (Germany, F.R.). Inst. of Meteorologie.
For primary bibliographic entry see Field 5B.
W91-08038

SEMI-AUTOMATED COLORIMETRIC AND ENZYMATIC ASSAYS FOR AQUATIC ORGANISMS USING MICROPLATE READERS.
Institut Francais de Recherche pour l'Exploitation de la Mer, Nantes.
F. Galgani, and G. Bocquene.
Water Research WATRAG, Vol. 25, No. 2, p 147-150, February 1991. 6 fig, 1 tab, 5 ref.

Descriptors: *Aquatic life, *Colorimetry, *Enzymes, *Marine biology, *Testing procedures, Assay, Automation, Costs, Kinetics, Proteins.

A semi-automated method for colorimetric and enzymatic assays using a microplate reader was developed for determining enzymatic activity in marine organisms. This method enables simultaneous assays of an extended number of colorimetric measurements of protein concentration and acetylcholinesterase activity in organisms. The correlation coefficient of the results obtained by conventional methods using a spectrophotometer and those obtained using a microplate reader was 0.98 for acetylcholinesterase and 0.99 for protein determination. The variation coefficient for all assays was lower than 7%. The method is useful for fast determination of protein concentration and enzymatic measurements including inhibition studies and calculation of kinetic parameters. Three advantages are featured in comparison with classical methods. First is the possibility of hundreds of measurements within time periods ranging from minutes to hours. The second advantage is the low cost of the system, and the third is the reduced volume of the system that enables the system to work on-board during a scientific cruise or to be decentralized. (Author's abstract)
W91-08048

PB(II) REMOVAL FROM KAOLINITE BY ELECTROKINETICS.
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5G.
W91-08080

CHROMATOGRAPHIC SEPARATION AND DETERMINATION OF CARCINOGENIC BENZ(C)ACRIDINES IN CREOSOTE OILS.
Meiji Coll. of Pharmacy, Tokyo (Japan).
For primary bibliographic entry see Field 5A.
W91-08107

DETERMINATION OF PHOSPHATE IN WATERS BY FLOW INJECTION ANALYSIS.
Universitat de les Illes Balears, Palma de Mallorca (Spain). Dept. de Chemistry.
F. Mas, J. M. Estela, and V. Cerda.
Water, Air and Soil Pollution WAPLAC, Vol. 52, No. 3/4, p 359-368, 1990. 8 fig, 4 tab, 44 ref.

Descriptors: *Analytical methods, *Phosphates, *Pollutant identification, *Spectrophotometry, *Water analysis, *Water quality monitoring, Chemical interference, Molybdenum, Performance evaluation.

Most of the methods for the determination of phosphorus have major short comings such as color instability, interference by As and Cu, the length of time required for full color development, and a low sensitivity or the absorbance of the blank. Optimum conditions for application of the reaction between Rhodamine B and polyphosmolybdate, to develop a spectrophotometric method for the determination of phosphate at the ppb level in natural water samples included the use of polyvinyl alcohol as a color stabilizer, sulfuric acid concentrations of 0.9N, molybdate concentrations of 0.026M and Rhodamine concentrations of 0.00006 M. A flow injection system with a spectrophotometric detector was used. Phosphate containing samples are introduced into a water carrier stream which reacts in a manifold with molybdate and Rhodamine B in an acid medium to yield a complex whose absorbance is monitored at 586 nm. The proposed method was applied to the determination of phosphate in various types of water: tap, ground, and rain. The results obtained were consistent with those found by the Molybdene Blue method except for the tap water samples which yielded smaller results by the proposed method. The method developed is applicable to the determination of phosphate ion at the ppb level at a rate of 55 samples per hour, and is faster and more sensitive than the Malachite Green method. (Doyle-PTT)
W91-08122

INTERACTION OF PH, DISSOLVED ORGANIC CARBON, AND TOTAL CARBON IN THE DETERMINATION OF IONIC COPPER AND TOXICITY.
Washington Univ., Seattle. School of Fisheries.
For primary bibliographic entry see Field 5C.
W91-08159

GAS CHROMATOGRAPHIC-MASS SPECTROMETRIC ANALYSIS OF URBAN-RELATED AQUATIC AND AIRBORNE VOLATILE ORGANIC COMPOUNDS: STUDY OF THE EXTRACTS OBTAINED BY WATER CLOSED-LOOP STRIPPING AND AIR ADSORPTION WITH CHARCOAL AND POLYURETHANE FOAM.
Centro de Investigacion y Desarrollo, Barcelona (Spain). Dept. of Environmental Chemistry.
For primary bibliographic entry see Field 5A.
W91-08179

ORGANIC CHEMICAL ANALYSIS OF GROUND WATER IN LOUISIANA: WATER YEARS 1984-88.
Geological Survey, Baton Rouge, LA. Water Resources Div.
For primary bibliographic entry see Field 5A.
W91-08183

EFFECTIVENESS OF THE ADDITION OF ALKALINE MATERIALS AT SURFACE COAL MINES IN PREVENTING OR ABATING ACID MINE DRAINAGE: PART 1. GEOCHEMICAL CONSIDERATIONS.
Geological Survey, Harrisburg, PA.
For primary bibliographic entry see Field 5G.
W91-08189

EFFECTIVENESS OF THE ADDITION OF ALKALINE MATERIALS AT SURFACE COAL MINES IN PREVENTING OR ABATING ACID MINE DRAINAGE: PART 2, MINE SITE CASE STUDIES.
Pennsylvania Dept. of Environmental Resources, Harrisburg.

For primary bibliographic entry see Field 5G.
W91-08190

2L. Estuaries

RELATIONSHIP BETWEEN SUBSTRATE CONCENTRATION AND OXIDATION OF AMMONIUM AND METHANE IN A STRATIFIED WATER COLUMN.
California Univ., Santa Cruz. Inst. of Marine Sciences.
For primary bibliographic entry see Field 2K.
W91-07307

REVIEW OF MANGROVE AND COASTAL ECOSYSTEMS IN WEST AFRICA AND THEIR POSSIBLE RELATIONSHIPS.
British Museum of Natural History, London (England). Dept. of Botany.
D. M. John, and G. W. Lawson.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 31, No. 5, p 505-518, November 1990. 1 fig, 1 tab, 74 ref.

Descriptors: *Coastal environment, *Coastal lagoons, *Deltas, *Ecosystems, *Estuaries, *Mangrove swamps, *Mangrove trees, *Marine environment, *West Africa, Crustaceans, Fish, Fisheries, Forests, Juveniles, Marine pollution, Migration, Path of pollutants, Productivity, Resources management, Succession, Temporal variation, Tidal floods.

Mangrove forests, which in West Africa cover an area of over 27,000 sq km of deltas, estuaries, and lagoons, are intimately linked to the offshore coastal ecosystem. Regularly influenced and disturbed by the seasonal freshwater and diurnal tidal flooding, the forests exhibit features of an immature ecosystem, namely low species diversity and high productivity. The excess organic production is exploited by many marine species especially fishes and crustaceans that enter the mangrove environment as juveniles and return to the sea as adults for reproductive purposes. The beneficial effects on marine fisheries of this net energy outflow are at risk from anthropogenic influences causing pollution or destruction of the mangrove ecosystem. Intense interdisciplinary work on this problem is in progress on the lagoons of the Ivory Coast, but further research on other parts of the West African mangrove ecosystem, especially on the Niger delta, needs to be undertaken to provide the scientific basis for the proper management of this valuable natural resource. (Author's abstract)
W91-07308

PLANT BIOMASS AND NUTRIENT FLUX IN A MANAGED MANGROVE FOREST IN MALAYSIA.
University of Science, Penang (Malaysia). School of Biological Sciences.
W.-K. Gong, and J.-E. Ong.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 31, No. 5, p 519-530, November 1990. 6 tab, 29 ref.

Descriptors: *Biomass, *Forest management, *Malaysia, *Mangrove swamps, *Nutrient concentrations, *Nutrient transport, *Plant physiology, *Resources management, *Wetlands, Calcium, Ecosystems, Manganese, Matang Mangrove Forest, Nitrogen, Nutrient export, Phosphorus, Sodium, Temporal variation.

As a first step to determining the quantitative relationship between the export of material and the areal extent of mangroves, the biomass and nutrients contained in the mangrove trees and the release of these nutrients to the ecosystem annually were determined for the 40,800 Matang Mangrove Forest Reserve, a managed mangrove forest in Malaysia. The total standing biomass of the Matang Mangrove Forest is estimated to be 8.26 million tons of dry matter. Biomass released annually from the mangrove trees in the Matang system is 1,015,980 tons. Of this biomass, 559,500 tons (55%) is found as dead trees, 396,840 tons (39%) as small litter, and 59,460 (6%) as slash left behind after thinning and harvesting. The amounts of macronutrients (N, P, K, Ca, Mn, and Na) released annually are 12,210, 11,870, and 2690 tons (through litter, dead trees, and slash, respectively). Using the figure of 50% export, the export of biomass and nutrients from the Matang Mangroves through leaf litter alone is estimated as 158,300 and 5100 tons annually, or 3.9 and 0.1 ton/ha/yr, respectively. (Author's abstract)
W91-07309

RELATIONSHIP BETWEEN NITROGEN FIXATION AND TIDAL EXPORTS OF NITROGEN IN A TROPICAL MANGROVE SYSTEM.
Australian Inst. of Marine Sciences, Townsville.
For primary bibliographic entry see Field 2I.
W91-07310

LONGITUDINAL DIFFUSION IN MANGROVE-FRINGED TIDAL CREEKS.
James Cook Univ. of North Queensland, Townsville (Australia). Dept. of Physics.
For primary bibliographic entry see Field 2I.
W91-07311

DYNAMICS, FLUSHING AND TRAPPING IN HINCHINBROOK CHANNEL, A GIANT MANGROVE SWAMP, AUSTRALIA.
Australian Inst. of Marine Sciences, Townsville.
E. Wolanski, Y. Mazda, B. King, and S. Gray.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 31, No. 5, p 555-579, November 1990. 18 fig, 34 ref.

Descriptors: *Australia, *Flushing, *Hinchinbrook Channel, *Mangrove swamps, *Tidal currents, *Tide lands, *Wetlands, Channels, Coastal areas, Continental shelf, Mathematical models, Open channels, Residence time, Temporal distribution, Water exchange.

Hinchinbrook Channel is a 44 km long tidal channel connected at its northern and southern ends to the continental shelf of the Great Barrier Reef. The channel drains 164 sq km of mangrove swamps, and also the Herbert River. The dynamics within the channel and the flushing of the fringing mangrove swamps were studied both in the field and using numerical models. The dominant currents are tidal semi-diurnal and are due to two nearly identical tidal waves entering the channel at its northern and southern openings and meeting in the middle. The mangrove swamps contribute significantly to the tidal dynamics. When the Herbert River discharge is small, net residual currents are negligible even in the presence of wind and the residence time of water is about two months. Flushing of the fringing mangrove swamps is largely controlled by the trapping effect in the mangrove swamps, and is slow with an e-fold residence time of about 54 days. On the northern end, the mangrove-fringed channel is wide and shallow, and a barotropic, coastal boundary layer is formed, due to shallow water effects and trapping in mangrove swamps. This boundary layer results in a long-term (2 weeks) trapping of water along the mangrove-fringed coast in calm weather. Thus, coastal waters are continuously exchanged and mixed with mangrove swamp waters, but mixing between coastal and offshore waters is much slower. (Author's abstract)
W91-07312

EFFECT OF MANGROVE DETRITAL OUTWELLING ON NUTRIENT REGENERATION AND OXYGEN FLUXES IN COASTAL SEDIMENTS OF THE CENTRAL GREAT BARRIER REEF LAGOON.
Australian Inst. of Marine Sciences, Townsville.
D. M. Alongi.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 31, No. 5, p 581-598, November 1990. 5 fig, 6 tab, 38 ref. ARC Grant 86/0708.

Descriptors: *Australia, *Coastal lagoons, *Detritus, *Great Barrier Reef, *Mangrove swamps, *Nutrient concentrations, *Nutrient transport, *Outwelling, *Oxygen transfer, *Sediment chemistry, *Wetlands, Coastal environment, Cycling nutrients, Ecosystems, Nitrogen, Organic carbon, Phosphorus, Phytoplankton, Primary productivity, Tides.

The effect of tidal outwelling of mangrove detritus on sediment nutrient chemistry, nutrient regeneration and oxygen fluxes was examined in a coastal area of the central Great Barrier Reef. Organic carbon and total nitrogen concentrations ranged from 0.2 to 3.9%, and 0.01 to 0.18%, by sediment dry weight (DW), respectively, and were highest at stations receiving the greatest quantities of mangrove litter. Total phosphorus concentrations ranged from 0.013 to 0.048% by DW, but did not relate to outwelling. The effect of outwelling on dissolved inorganic nutrients in porewaters was less clear, with concentrations closely related to sediment type and obscured by contribution from continental runoff. Ammonium and silicate were in greatest concentration at most sites, followed by phosphate, nitrate and nitrate. Directly measured fluxes of dissolved inorganic nutrients across the sediment-water interface were either undetectable or small, and not related to outwelling. Addition of mangrove litter to boxcore samples incubated for 10 days in the laboratory did not affect rates of dissolved inorganic nutrient release. Organic consumption rates ranged from 8.7 to 60.2 mmol O2/sq m/day and were highest at most sites closest to mangrove forests. Rates of net community primary production were either undetectable or low, ranging from 12 to 77 mg C/sq m/day. Much of the deposited mangrove litter is refractory, but the amount of sedimented material appears to be great enough to significantly enrich bulk concentrations of particulate carbon and nitrogen, and rates of oxygen consumption. Benthic nutrient regeneration contributes only a small proportion to the daily nitrogen and phosphorus demand of coastal phytoplankton, implying supplementation from continental runoff and/or high rates of pelagic recycling. (Author's abstract)
W91-07313

EPIBENTHOS OF MANGROVE WATERWAYS AND OPEN EMBAYMENTS: COMMUNITY STRUCTURE AND THE RELATIONSHIP BETWEEN EXPORTED MANGROVE DETRITUS AND EPIFAUNAL STANDING STOCKS.
Australian Inst. of Marine Sciences, Townsville.
P. A. Daniel, and A. I. Robertson.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 31, No. 5, p 599-619, November 1990. 5 fig, 4 tab, 67 ref.

Descriptors: *Bays, *Benthos, *Detritus, *Ecosystems, *Estuaries, *Mangrove swamps, *Nutrient concentrations, *Nutrient transport, *Species composition, *Standing stocks, *Tidal rivers, *Wetlands, Biomass, Comparison studies, Residence time, Species diversity, Streams, Tides.

The epibenthos inhabiting creek bottoms in a tidally influenced mangrove forest, a mangrove-lined estuary and several sites in two open embayments, all in Queensland, Australia was sampled on four occasions between August 1986 and June 1987. The inshore (mangrove habitats)-offshore (embayment) patterns in total faunal taxonomic richness (means ranging from 0 to 32.5 taxa per trawl) and density (range of means, <1.55 individuals/sq m) were generally complex, with patterns across the gradient changing seasonally. Patterns in total biomass (range of means 0 to 740 mg/sq m) were clearer, with highest biomasses recorded in May (post-wet season) and lowest in February (mid-wet season), with no significant cross-habitat gradient in biomass. Densities and biomasses were somewhat low, probably owing to the physically harsh conditions available to epibenthos and to the low quality of mangrove detritus as a food source. The significant difference in the structure of epibenthic communities in mangrove and embayment habitats in the dry season months (August and October) was likely due to the longer residence time of water in mangrove waterways at that time of the year. Greater tidal amplitudes and increased tidal current velocities in February transported mangrove detritus and many faunal taxa into embayments. Variation in the quantities of exported mangrove detritus in nettings explained significant pro-

portions of the variance in total (and component taxa) epibenthic standing stocks in mangrove and embayment habitats. (Author's abstract)
W91-07314

GROUNDWATER FLOW IN THE BASHITA-MINATO MANGROVE AREA, AND ITS INFLUENCE ON WATER AND BOTTOM MUD PROPERTIES.
Tokai Univ., Shizouka (Japan). Faculty of Marine Science and Technology.
Y. Mazda, H. Yokuchi, and Y. Sato.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 31, No. 5, p 621-638, November 1990. 15 fig, 17 ref.

Descriptors: *Groundwater movement, *Japan, *Mangrove swamps, *Mangrove trees, *Mud, *Sediment distribution, *Surface-groundwater relations, *Wetlands, Algae, Anoxic conditions, Chlorophyll a, Iriomote Island, Lagoons, Photosynthesis, Sediment chemistry, Soil physical properties, Tides, Water level fluctuations.

In the Bashita-Minato mangrove lagoon in Iriomote Island, Japan, the following parameters were measured from 1985 to 1988: the groundwater level in the shore bank between the lagoon and the open sea, the water levels in the lagoon and the open sea, the water properties near the bottom, and chlorophyll a in the bottom soil of the lagoon. The movement of groundwater depends on the soil characteristics and the difference in water levels in the lagoon and in the ocean, and flows towards the lagoon, modulated by the tidally reversing flow with exponentially dampened amplitude and linearly delayed phase. The groundwater movements cause inflow and outflow with the tidal cycle through the bottom of the lagoon. The momentum of the inflowing water mixes the bottom water with the overlying water, resulting in dismantlement of the anoxic conditions in the bottom layer at the tidal period. The benthic algae photosynthesizing on the bottom sediment are entrained in the mud by the outflow of the lagoon water through the bottom layer. The groundwater flow appears to play an important role in determining the water properties and the sediment conditions of the mangrove area. (Author's abstract)
W91-07315

FACTORS AFFECTING THE HYDROCHEMISTRY OF A MANGROVE TIDAL CREEK, SEPETIBA BAY, BRAZIL.
Universidade Federal Fluminense, Niteroi (Brazil). Dept. de Geoquimica.
For primary bibliographic entry see Field 2K.
W91-07316

OBSERVATIONS AND ANALYSIS OF A STRATIFICATION-DESTRATIFICATION EVENT IN A TROPICAL ESTUARY.
Plymouth Marine Lab. (England).
R. J. Uncles, J. E. Ong, and W. K. Gong.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 31, No. 5, p 651-665, November 1990. 6 fig, 24 ref, append.

Descriptors: *Destratification, *Ecosystems, *Estuaries, *Malaysia, *Mangrove swamps, *Mathematical models, *Nutrient transport, *Stratification, *Tropical regions, Diffusivity, Eddies, Freshwater, Mangrove trees, Mixing, Runoff, Salinity, Seasonal variation, Sungai Merbok Estuary, Viscosity.

A data set comprising 31 continuous tidal cycles was collected in the Sungai Merbok Estuary, Malaysia, in June 1987 as part of an ecological study of nutrient fluxes from a tropical mangrove estuary. Currents, salinity and salinity stratification at a deep-channel (15 m) station near the mouth of the Merbok Estuary showed a pronounced spring-neap variability. The slow currents and weak vertical mixing at neap tides favored the formation of a stratified water column and generated a neap-spring cycle of water column stabilization and destabilization. A strong stratification event occurred during the period of observations. This event was partially driven by a modest freshwater spate which coincided with neap tides. An eddy-viscosity-diffusivity model of the stratification, which assumed a constant, longitudinal salinity gradient, demonstrated a pronounced stratification-destratification cycle due to neap-spring variations in vertical mixing. Larger and more realistic stratification was modelled when the estimated, time-varying longitudinal salinity gradient was incorporated. This gradient maximized in response to the peak in freshwater runoff. The measured and modelled density-driven circulations showed qualitative similarities and were of the order of 10 cm/sec at neap tides. The circulation was weaker during spring tides. The tidally-filtered salt transport due to vertical shear was directed up-estuary and was an order of magnitude smaller during spring tides. Stratification during neap tides means that mangroves will be inundated by the fresher surface waters for about half the spring-neap cycle. (Author's abstract)
W91-07317

MIXING, TRAPPING AND OUTWELLING IN THE KLONG NGAO MANGROVE SWAMP, THAILAND.
Chulalongkorn Univ., Bangkok (Thailand). Dept. of Marine Science.
G. Wattayakorn, E. Wolanski, and B. Kjerfve.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 31, No. 5, p 667-688, November 1990. 13 ref, 4 fig, 36 ref.

Descriptors: *Estuaries, *Klong Ngao Estuary, *Mangrove swamps, *Mixing, *Outwelling, *Thailand, *Trapping, *Wetlands, Evaporation ponds, Flooding, Flushing, Homogeneity, Nutrient concentrations, Nutrient transport, Seasonal distribution, Sediment transport, Streams, Tides.

The Klong Ngao estuary in Thailand is a 7.5 km long tidal creek facing the Andaman Sea and drains 11.5 sq km of mangrove swamps. Physical processes in the estuary differ greatly from the wet season to the dry season. In the dry season, vertical homogeneity prevails and the swamp behaves like an evaporation pond. Salt and water are trapped upstream, longitudinal gradients result and, through tidal dispersion, nutrient outwelling may result for silica oxide, possibly for nitrite and nitrate, but not phosphate. The outflow is trapped in a coastal boundary layer. In the wet season, short-lived local floods generate a strong stratification in salinity and episodical flushing of the estuary and may make measurements of nutrient budgets inconclusive. The Klong Ngao mangrove swamp traps land-derived sediments in the wet season. (Author's abstract)
W91-07318

USE OF A MANGROVE ESTUARY AS A NURSERY AREA BY POSTLARVAL AND JUVENILE BANANA PRAWNS, PENAEUS MERGUIENSIS DE MAN, IN NORTHERN AUSTRALIA.
Commonwealth Scientific and Industrial Research Organization, Cleveland (Australia). Marine Labs.
D. J. Vance, M. D. E. Haywood, and D. J. Staples.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 31, No. 5, p 689-701, November 1990. 8 fig, 1 tab, 21 ref. Fishing Industry Research Trust Account, Grants 1981/14 and 1985/85.

Descriptors: *Australia, *Estuaries, *Juvenile growth stage, *Mangrove trees, *Nursery areas, *Shrimp, *Wetlands, Abundance, Animal behavior, Distribution patterns, Embley River, Fisheries, Gulf of Carpentaria, Migration, Mud banks, Rivers, Salinity, Size classes, Streams, Survival.

In the Embley River, Gulf of Carpentaria, Australia, the largest catches of the commercially important banana prawn, Penaeus merguiensis, were made on mangrove-lined, steeply sloping mud banks. The upstream limit of distribution of P. merguiensis was found to coincide with the distribution of broad bands of fringing mangrove forests but, except in the wet season, was not related to salinity levels. Although some postlarval P. merguiensis settled on all habitat types in the estuary, large catches were only taken on the mangrove-lined banks. Catches of both postlarvae and juveniles in the upstream reaches of a small creek were almost five times higher than those in the river area near the creek mouth. Moreover, prawns in the 2 to 4 mm carapace length (CL) size class were poorly represented in the river but were abundant in catches in the small creek, suggesting that either the survival rate of postlarvae is highest in the upper reaches of the small creeks, or that the small prawns are migrating from the main river into the creek. As prawns increase in size above 5 mm CL, they appear to take part in daily tidal migrations from small creeks to the river and begin a gradual migration from the creeks to the river. (Author's abstract)
W91-07319

FISH AND PRAWN COMMUNITIES OF A MALAYSIAN COASTAL MANGROVE SYSTEM, WITH COMPARISONS TO ADJACENT MUD FLATS AND INSHORE WATERS.
Malaya Univ., Kuala Lumpur (Malaysia). Dept. of Zoology.
V. C. Chong, A. Sasekumar, M. U. C. Leh, and R. D'Cruz.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 31, No. 5, p 703-722, November 1990. 3 fig, 6 tab, 52 ref.

Descriptors: *Ecosystems, *Fish, *Malaysia, *Mangrove swamps, *Mud flats, *Shrimp, *Species composition, *Wetlands, Coastal areas, Distribution patterns, Fish migration, Fisheries, Intertidal areas, Juvenile growth stage, Similarity coefficients.

The fish and prawn communities of four coastal habitats in Selangor, Malaysia: (1) coastal mangrove swamps; (2) mud flats, including subtidal regions; (3) near inshore waters; and (4) far inshore waters, were examined with respect to species composition, abundance, diversity, similarity and sexual maturity. The number of fish species sampled for these habitats were 119, 70, 58, and 92 species, respectively. For prawns, the number of species were 9, 16, 8 and 14 respectively. The mangrove community comprised 63 to 99% juvenile fish and 100% prawn. Despite a high species richness, it was low in fish species diversity due to the dominance (70%) of six species of fish of low economic value. In contrast, the prawn community was poor in species, and was dominated by three Penaeus spp. of high economic value. The intertidal mudflat community is largely transient and comprised mainly of species from both the mangrove and subtidal habitats. Fifty-six percent of the fish population and 62.6% of the prawn population were juveniles. Many of the inshore fish and prawn species were also common species found in mangrove and mudflat habitats. Similarity coefficients indicate that the inshore fish and prawn communities are more similar to those of mud flats than mangroves. However, maturity studies indicate that only five species of fish are true migrants, that the majority of the fish species (juveniles and adults) are ubiquitous with a distribution that extends several nautical miles offshore. Results of this study indicate that tropical coastal mangroves function more importantly as feeding grounds than as nursery grounds for juveniles of commercially important fish species. Mangroves and mud flats are utilized during flood tides by many periodic foragers from the inshore waters. However, this study confirms that coastal mangroves and mud flats are important nursery areas for commercially important prawn species. (Author's abstract)
W91-07320

RECRUITMENT, GROWTH AND RESIDENCE TIME OF FISHES IN A TROPICAL AUSTRALIAN MANGROVE SYSTEM.
Australian Inst. of Marine Sciences, Townsville.
A. I. Robertson, and N. C. Duke.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 31, No. 5, p 723-743, November 1990. 7 fig, 2 tab, 72 ref.

Descriptors: *Australia, *Fisheries, *Growth, *Mangrove swamps, *Population dynamics, *Populations, *Species composition, *Tropical regions, *Wetlands, Animal behavior, Distribution patterns,

Fish behavior, Population density, Recruitment, Residence time, Seasonal distribution.

Twenty fish species accounted for >96% of the catch by numbers in mangrove habitats in Alligator Creek, in tropical Queensland. The timing of recruitment, residency status, the period of residence and growth of fish during the time spent in the mangrove habitat was assessed by examining gonad maturity and following changes in size-frequency plots for each species over 13 months. Five species were permanent residents, completing their life cycles in mangrove swamps; eight were 'long-term' temporary residents, being present for approximately one year as juveniles before moving to other near-shore habitats; and seven were 'short-term' residents or sporadic users of the mangrove habitat. Among the latter group, four species lived in the mangrove habitat for between 1 and 4 consecutive months, while three engraulid species appeared to move rapidly, and often, between mangrove and other near-shore habitats. One of the resident species spawned and recruited throughout the year, but recruitment for most species was highly seasonal, being concentrated in the late dry season (October) to mid-wet season (February) period. Temporary resident species dominated the fish community in the wet season (December to April), but resident species comprised more than 90% of total fish numbers in the mid-dry season (August) after temporary residents left the mangroves in the early dry season. Several species had more than one peak of recruitment during the wet season. Only nine of the twenty species examined are strictly dependent on mangrove-lined estuaries, the remaining 11 are captured in significant numbers in other near-shore habitats. Only four of the twenty species are of direct commercial importance in Australia, but most are major prey for several valuable, commercial species harvested both within mangrove habitats and in adjacent shallow shelf habitats. (Author's abstract)
W91-07321

QUANTIFYING EXTERNAL AND INTERNAL NITROGEN AND PHOSPHORUS POOLS, AS WELL AS NITROGEN AND PHOSPHORUS SUPPLIED THROUGH REMINERALIZATION, IN COASTAL MARINE PLANKTON BY MEANS OF A DILUTION TECHNIQUE.
Oslo Univ. (Norway). Dept. of Biology.
For primary bibliographic entry see Field 2K.
W91-07322

EVALUATION OF IRON AS A TRIGGERING FACTOR FOR RED TIDE BLOOMS.
Maine Univ., Walpole. Dept. of Oceanography.
M. L. Wells, L. M. Mayer, and R. R. L. Guillard.
Marine Ecology Progress Series MESEDT, Vol. 69, No. 1/2, p 93-102, January 10, 1991. 6 fig, 55 ref. Sea Grant No. R/FMD-161.

Descriptors: *Algal blooms, *Gulf of Maine, *Iron, *Limiting nutrients, *Red tide, Algal toxicity, Coastal waters, Dinoflagellates, Georges Bank.

The relationship between iron and blooms of the toxic dinoflagellate Alexandrium tamarense (Balech) (formerly Gonyaulax tamarensis var. excavata (Lebour)) was examined using a chemical method that estimated the biological availability of iron in seawater. The iron requirement for optimal growth of A. tamarense in sequential batch culture (ca 3 nM available iron) was compared with iron concentrations in waters of the Gulf of Maine, USA. Results indicated that iron did not limit growth of the organism in nearshore coastal waters or over Georges Bank, but that the organism may have been iron-limited in Gulf of Maine basin waters. The distribution of A. tamarense in the Gulf of Maine is consistent with these iron data. Red tide outbreaks in the nearshore environment did not correlate with changes in total iron or the estimated iron availability. Although iron did not appear to trigger outbreaks of A. tamarense in Maine coastal waters, the findings are consistent with suggestions that pulsed inputs of iron may be important for the development of toxic dinoflagellate blooms in regions where outbreaks are initiated offshore. (Author's abstract)
W91-07323

EFFECTS OF IRRADIANCE ON NITROGEN UPTAKE BY PHYTOPLANKTON: COMPARISON OF FRONTAL AND STRATIFIED COMMUNITIES.
British Columbia Univ., Vancouver. Dept. of Oceanography.
W. P. Cochlan, N. M. Price, and P. J. Harrison.
Marine Ecology Progress Series MESEDT, Vol. 69, No. 1/2, p 103-116, January 10, 1991. 4 fig, 6 tab, 90 ref.

Descriptors: *Algal growth, *Irradiation, *Light effects, *Nitrogen, *Nutrient concentrations, *Photosynthesis, *Solar radiation, *Stratification, British Columbia, Chlorophyll, Limiting nutrients, Mathematical models, Michaelis-Menten equation, Photon flux densities, Phytoplankton, Tracers.

Rates of nitrate ion and urea uptake by phytoplankton in the shallow and deep chlorophyll layers of the Strait of Georgia, British Columbia (Canada) were measured, over a gradient of photosynthetic photon flux densities (PPFD), using the nitrogen-15 tracer technique. The results of these experiments could be fitted with a hyperbolic function similar to the Michaelis-Menten equation and included a term for dark uptake. Half-saturation constants for light-dependent uptake of urea and nitrate ions ranged from 0 to 14% of the surface PPFD, and dark uptake of both urea and nitrate ions ranged from 0 to 58% of the uptake at saturating PPFD. Although the importance of dark uptake increased with increased nitrogen limitation, the dramatic difference in phytoplankton community composition between the nitrogen-replete frontal waters and the nitrogen-depleted stratified waters precludes a simple explanation of PPFD effect(s) on nitrogen uptake based solely on phytoplankton nitrogen status. (Author's abstract)
W91-07324

ANNUAL CYCLE OF PARTICLE SIZE FRACTION AND PHYTOPLANKTON BIOMASS IN THE NORTHERN BALTIC PROPER.
Institute of Ecology and Marine Research, Tallinn (USSR).
M. Kahru, E. Kaasik, and A. Leeben.
Marine Ecology Progress Series MESEDT, Vol. 69, No. 1/2, p 117-124, January 10, 1991. 8 fig, 3 tab, 31 ref.

Descriptors: *Algal growth, *Baltic Sea, *Biomass, *Particle size, *Periodicity, *Phytoplankton, Algal blooms, Blue-green algae, Chlorophyll, Diatoms, Distribution patterns, Ecosystems, Field tests, Mathematical models, Seasonal variation, Spatial distribution, Species composition, Temporal distribution, Zooplankton.

A large data set of particle concentrations in the range 1 to 100 microm, chlorophyll a, and associated measurements from the surface waters of the northern Baltic proper during 1985 to 1989 was analyzed to construct spatially and temporally averaged annual time curves of particle size fractions and phytoplankton biomass. Chlorophyll a concentration was well correlated with the 28 to 73 microm size fraction and had 2 seasonal peaks: in April-May, corresponding to the diatom spring bloom, and in August, corresponding to the late-summer bloom of blue-green algae. The two maxima were separated by the early summer minimum when the 1 to 10 microm particle fractions corresponding to a mixed assemblage of small phytoplankton and microheterotrophs reached their maxima. The largest particles (163 to 1000 microm), corresponding to smaller mesozooplankton, reached their maximum in July-August before the blue-green maximum. Automated particle counting is well suited for routine monitoring of pelagic systems as it reveals all major shifts in the planktonic community. (Author's abstract)
W91-07325

EVALUATION OF MEASUREMENTS AND CALCULATION OF PRIMARY PRODUCTION IN THE DOGGER BANK AREA (NORTH SEA) IN SUMMER 1988.
Nederlands Inst. voor Onderzoek der Zee, Texel.
R. Riegman, and F. Colijn.
Marine Ecology Progress Series MESEDT, Vol. 69, No. 1/2, p 125-132, January 10, 1991. 2 fig, 4 tab, 39 ref.

Descriptors: *Carbon radioisotopes, *Dogger Bank, *North Sea, *Phytoplankton, *Primary productivity, *Stratification, Algal growth, Biomass, Field tests, Filtration, Irradiation, Temporal variation, Water column.

Primary production was measured during a survey in the Dogger Bank area, where both stratified and non-stratified conditions existed in July-August 1988. Daily primary production was calculated, based on carbon-14-labeled fixation rates in an incubator with an artificial light source, depth profiles of in situ irradiance, and vertically heterogeneous phytoplankton distributions. Values ranged among stations from 300 to 2200 mg C/sq m/day. Average primary production in the Dogger Bank area was estimated at 1.2 g C/sq m/day. Variation in cloudiness affected primary productivity by a factor of 4.5. Calculations based on surface samples alone showed an average areal primary production underestimate of 17%. After correction for the uneven vertical biomass distribution, primary production was still underestimated by 12% as a result of photoadaptation. Calculated daily primary production rates based on in situ incubations and on incubator measurements deviated by only 5%. Light quality did not have a significant effect on water column productivity. Size-dependent primary production based on post-incubation filtration onto 5 microm filters showed that, on average, 84% of total primary production was in the >5 microm fraction. (Author's abstract)
W91-07326

ORGANIC CARBON DECOMPOSITION, PRIMARY AND BACTERIAL PRODUCTIVITY, AND SULPHATE REDUCTION, IN TROPICAL SEAGRASS BEDS OF THE GULF OF CARPENTARIA, AUSTRALIA.
Commonwealth Scientific and Industrial Research Organization, Cleveland (Australia). Marine Labs.
P. C. Pollard, and D. J. W. Moriarty.
Marine Ecology Progress Series MESEDT, Vol. 69, No. 1/2, p 149-159, January 10, 1991. 8 fig, 4 tab, 41 ref. Marine Science and Technologies Grant No. 81/0319.

Descriptors: *Australia, *Bacterial physiology, *Bacterial productivity, *Chemical reduction, *Decomposition, *Organic carbon, *Oxidation, *Primary productivity, *Sea grasses, *Sulfates, Algal growth, Carbon, Carbon cycle, Coastal areas, Ecosystems, Fermentation, Field tests, Food chains, Gulf of Carpentaria, Oxygen concentrations, Plant physiology, Species composition.

The oxidation of organic carbon by bacteria in tropical seagrass communities was studied in austral summer 1986 to 1987. The major seagrass species were Enhalus acoroides, Syringodium isoetifolium, Cymodocea serulata, Thalassia hemprichii and Cymodocea rotundata. Seagrass gross productivity, determined by a lacunal gas technique, ranged from 0.5 to 4.3 g C/sq m/day. In comparison, gross community productivity, measured from diurnal changes in oxygen concentration in the water column, ranged from 4 to 9 g C/sq m/day. Macroalgae, epibenthic and epiphytic algae made to the major contribution to gross primary production in the communities studied, contributing 40 to 90% of gross primary production. Most of the primary production was utilized by hydrolytic and fermentative bacteria and was ultimately oxidized by sulphate-reducing bacteria. Hydrolytic (aerobic) and fermentative bacterial productivity, determined from rates of incorporation of tritiated thymidine into DNA, ranged from 3 to 13 g C/sq m/day (integrated over a depth of 12 cm in the sediment). The highest rates of sulphate reduction, determined with sulfur-35, coincided with the below-ground distribution of seagrass roots and rhizomes. Between 1.7 and 2.2 g C/sq m/day was oxidized to carbon dioxide by the sulfate-reducing bacteria; this is equivalent to 30 to 80% of the net community productivity. (Author's abstract)
W91-07327

PHOTOSYNTHESIS, RESPIRATION AND WHOLE PLANT CARBON BUDGET OF THE SEAGRASS THALASSIA TESTUDINUM.
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
J. W. Fourqurean, and J. C. Zieman.
Marine Ecology Progress Series MESEDT, Vol. 69, No. 1/2, p 161-170, January 10, 1991. 8 fig, 5 tab, 42 ref.

Descriptors: *Carbon cycle, *Irradiation, *Photosynthesis, *Plant metabolism, *Respiration, *Sea grasses, Biomass, Florida Bay, Mathematical models, Model studies, Nutrient concentrations, Oxygen requirements, Survival.

The photosynthesis versus irradiance (P/I) response of the seagrass Thalassia testudinum from Florida Bay, USA, was measured using the oxygen evolution of intact short shoots enclosed in sealed chambers, and found to have a light-saturated P/I behavior. All 4 of the commonly used mathematical formulations of the P/I curve, were of equal utility in describing the data. When fit to the data using a least-squares fitting procedure, they produced nearly identical lines explaining 90% of the variance in the data. The estimates of the P/I model parameters varied widely. Green photosynthetic leaves account for only 15.0% of the total biomass of Florida Bay T. testudinum. The remaining 85% is apportioned into belowground short shoots, rhizomes and roots. Leaves had higher respiration rates (7.4 microg oxygen/g/min) than the belowground structures (0.9 to 4.6 microg oxygen/g/min), and accounted for 42.6% of total plant respiration. The P/I curve and respiration data were used to build a daily carbon budget for Florida Bay T. testudinum. Estimated carbon fixation rates agreed closely with previously collected field carbon-14 uptake measurements. Under average summer light conditions, the budget was positive as deep as 4 m, suggesting that plants can survive at this depth. (Author's abstract)
W91-07328

ECOLOGICAL CONSEQUENCES OF DREDGING AND BOTTOM TRAWLING IN THE LIMFJORD, DENMARK.
Vandkvalitetsinstitutet, Hoersholm (Denmark).
For primary bibliographic entry see Field 6G.
W91-07329

IS THE ACTIVITY OF BENTHIC SUSPENSION FEEDERS A FACTOR CONTROLLING WATER QUALITY IN THE BAY OF BREST.
Universite de Bretagne-Occidentale, Brest (France). Lab. d'Oceanographie Biologie.
C. Hily.
Marine Ecology Progress Series MESEDT, Vol. 69, No. 1/2, p 179-188, January 10, 1991. 4 fig, 2 tab, 43 ref.

Descriptors: *Aquatic animals, *Bay of Brest, *Benthic fauna, *Eutrophication, *Filter feeders, *France, *Water pollution effects, *Water quality, Algal blooms, Animal behavior, Annual variation, Bays, Biomass, Distribution patterns, Dominance, Ecosystems, Fertilization, Mud, Phytoplankton, Population density, Primary productivity, Seasonal variation, Sediment types, Spatial distribution, Species composition, Succession, Tides.

In the Bay of Brest, France, suspension feeders are broadly dominant in the trophic structure of macrobenthic assemblages in terms of species number, number of individuals and biomass. A succession of species exists on an east-west gradient, which is an ecological continuum from a <10 m depth polyhaline muddy environment to a >20 m depth marine environment with coarse and clean sediments. The abundance of biogenic substrates (shells, calcareous algae, etc.) on the sediment surface favors a high development of sessile epifauna. Some species can locally proliferate, reaching 100 g organic dry weight/sq m. Fertilization of the bay by streams loaded with nutrients induces a very high primary production (280 g C/sq m/yr) characterized by high annual and seasonal variability of phytoplanktonic blooms. However, so far, eutrophication has not been observed. While water renewal by tidal currents is one important factor in the control of eutrophication, suspension feeder activity is undoubtedly another effective control factor. Benthic suspension feeders can filter 718,000,000 cubic m daily, which represents circa 30% of the total volume of the bay. The phytoplankton production is easily accessible to the benthos because of the relatively long water residence time and the high tidal current mixing. Spatial distribution of populations was found to be related to the tidal current distribution. (Author's abstract)
W91-07330

CONSPICUOUS DECLINE OF FUCUS IN KIEL BAY (WESTERN BALTIC): WHAT ARE THE CAUSES.
Kiel Univ. (Germany, F.R.). Inst. fuer Meereskunde.
H. Vogt, and W. Schramm.
Marine Ecology Progress Series MESEDT, Vol. 69, No. 1/2, p 189-194, January 10, 1991. 2 fig, 1 tab, 24 ref.

Descriptors: *Baltic Sea, *Eutrophication, *Fucus, *Kiel Bay, *Marine pollution, *Path of pollutants, *Phaeophyta, *Plant populations, *Population density, *Population dynamics, *Water pollution effects, Algal growth, Biomass, Comparison studies, Deposition, Dredging, Field tests, Irradiation, Species composition, Substrate availability, Water depth.

In the framework of investigations on possible effects of eutrophication on the macrophytobenthos in Kiel Bay (Western Baltic), a large-scale survey of the distribution and occurrence of the genus Fucus was carried out in 1987/1988. For large-scale quantitative mapping, underwater television was employed or direct observations from the water surface were made. Species composition and quantitative biomass were data were obtained by dredging and SCUBA diving. Comparison with the results of earlier investigations revealed a drastic decline in Fucus biomass from between 40,000 and 45,000 tons wet weight down to only 2,400 tons wet weight in 1987 to 1988,which means a decrease by 94 to 95%. Whereas Fucus vesiculosus as well as F. serratus were still frequent at depths below 2 m down to 13 m in the seventies, during our investigation Fucus spp. was not found in water depths greater than 2 m. Decreased light levels or increased epiphyte growth as a result of eutrophication, and the reduction of substrate for algal growth due to stone fishing (commercial gathering of rock for construction purposes) and sand deposition, are the main causes for the decline of Fucus spp. (Author's abstract)
W91-07331

VEGETATION DYNAMICS ON THE VIRGINIA BARRIER ISLANDS.
Old Dominion Univ., Norfolk, VA. Dept. of Biological Sciences.
G. F. Levy.
Virginia Journal of Science VJSCAI, Vol. 41, No. 4A, p 300-306, Winter 1990. 28 ref.

Descriptors: *Barrier islands, *Erosion, *Salt tolerance, *Vegetation, *Virginia, Accretion, Dunes, Flooding, History, Mortality, Nutrient concentrations, Salt stress, Scour, Species diversity, Storms, Succession.

The vegetation on the Virginia barrier islands is affected by oceanside erosion and accompanying salt spray which impact strand communities, and by bayside accretion which provides impetus for hydrarch succession. Controlling environmental complexes include: extent of flooding, soil moisture, soil nutrient levels and autogenic factors, as well as salt spray. Of great significance throughout this system is a salt spray gradient. During storms, salt spray and accompanying sand scouring can cause significant mortality and necrosis to relatively intolerant species. A variety of vegetation patterns are found on stable dunes, unstable dunes, interdunal depressions, sand flats, relic dunes and bayside sites of various physiographic aspects. Succession can be progressive, retrogressive, chronic-patchy or cyclic, depending on physiographic conditions. Historic, natural and anthropogenic impacts have disrupted communities and depauperized the flora. (Brunone-PTT)
W91-07363

PHYTOPLANKTON WITHIN THE VIRGINIA BARRIER ISLAND COMPLEX.
Old Dominion Univ., Norfolk, VA. Dept. of Biological Sciences.
H. G. Marshall, and C. E. Shomers.
Virginia Journal of Science VJSCAI, Vol. 41, No. 4A, p 427-432, Winter 1990. 1 tab, 12 ref.

Descriptors: *Barrier islands, *Coastal environment, *Phytoplankton, *Tidal effects, *Virginia, *Wetlands, Channels, Diatoms, Evaporation, Flooding, Ponds, Population dynamics, Rainfall, Salinity, Species composition, Storms, Water movement.

Behind the Virginia barrier islands are wetlands containing numerous channels of natural origin and varied depth that are tidally flushed daily, with the bordering wetlands inundated during spring tides and major storm periods. The region provides a high energy system where the water masses are continually being transferred and are well-mixed, oxygenated and exposed to nutrient rich drainage from upland and wetland sites. Phytoplankton populations within these channel islands are characterized as neritic and similar in dominant species (Skeletonema costatum), general composition (chain-forming diatoms, dinoflagellates, and piconanoplankton) and seasonal growth patterns to populations of the coastal waters in the mid-Atlantic bight. Differences in composition increase along a decreasing salinity gradient when compared to populations in a saline pond and an oligohaline lake. More stable environmental conditions are associated with the coastal and channel waters, in contrast to the temporary and permanent ponds. The ponds are subject to more severe environmental conditions, including storm flooding, salt spray, severe temperature and salinity ranges, and variable rainfall and evaporation patterns. Each pond, therefore, represents a unique habitat. (Brunone-PTT)
W91-07364

MARINE AMOEBAE IN WATERS OF CHINCOTEAGUE BAY, VIRGINIA: ECOLOGICAL SIGNIFICANCE OF 'OLD' AND 'NEW' SPECIES.
Rescon Associates, Inc., Royal Oak, MD.
T. K. Sawyer.
Virginia Journal of Science VJSCAI, Vol. 41, No. 4A, p 433-440, Winter 1990. 1 tab, 27 ref.

Descriptors: *Amebas, *Bioindicators, *Chincoteague Bay, *Marine environment, *Pathogens, *Protozoa, *Virginia, Animal diseases, Human diseases, Seawater, Species composition, Species diversity, Water quality.

Surface waters from Chincoteague Bay, Virginia, were sampled for marine amebas in 1971 to 1972. Seawater cultures yielded four new genera and 20 new species in addition to 16 genera and 15 species of previously described marine amebas. Among the 16 'older' genera, six were described during 1874 to 1912, six during 1921 to 1931, and four during 1950 to 1972. The description of 20 new species in 1975 indicated that marine amebas had not received adequate attention as important components of marine ecosystems. Several of the 'new' species are now recognized as indicators of healthy or stressed environments. Similarly, the 'old' genus Paramoeba Schaudinn, 1896 now includes a parasitic species that causes fatal diseases in blue crabs, Callinectes sapidus, and Acanthamoeba Volkonsky, 1931 includes several that may cause meningitis or blindness in humans. Coastal waters of Virginia are known to harbor free-living pathogenic amoeba that deserve further ecological and taxonomic study, especially in marshlands, tidal creeks, and rivers. Historical data on species diversity among marine amebas during 1971 to 1972 should provide a useful historical record for developing a water quality model for the shoreline of Chincoteague Bay as it undergoes further development. (Brunone-PTT)
W91-07365

SEASONAL COMPOSITION OF FINFISH IN WATERS BEHIND THE VIRGINIA BARRIER ISLANDS.
Virginia Inst. of Marine Science, Gloucester Point.
B. L. Norcross, and D. Hata.
Virginia Journal of Science VJSCAI, Vol. 41, No. 4A, p 441-461, Winter 1990. 11 fig, 2 tab, 22 ref.

Descriptors: *Barrier islands, *Fish populations, *Species composition, *Virginia, Distribution patterns, Fish migration, Fisheries, Juvenile growth stage, Lagoons, Marshes, Population dynamics, Salinity, Sampling, Seasonal distribution.

Semi-monthly sampling of finfish was conducted in the Virginia lagoons and marshes behind Parramore and Cedar Islands at Wachapreague Inlet, Cobb and Wreck Islands at Sand Shoal Inlet, and on the northwest side of Fisherman Island from September 1986 through September 1987. Although all lifestages were collected, the study focused on utilization of this area by juvenile finfish. Sixty-nine species of finfish were collected. Species diversity and abundance fluctuated widely among seasons. Both parameters were highest in the fall and lowest in winter. The most abundant species over all seasons and locations were silversides (Menidia menidia) and bay anchovy (Anchoa mitchilli). The most abundant commercially and recreationally important species collected were summer flounder (Paralichthys dentatus) and the sciaenids, croaker (Micropogonias undulatus), spot (Leiostomus xanthurus) and weakfish (Cynoscion regalis). As adults, these species migrate inward in the spring and leave in the fall, but newly recruited juveniles utilized these areas almost all year. Comparisons were made with results from the only other directed study in this area, and the differences can be attributed to gear size (size of trawl net mesh) and site (salinity and relative position in marsh). (Author's abstract)
W91-07366

DETERMINATION OF NITRITE AND NITRATE IN VENICE LAGOON WATER BY ION INTERACTION REVERSED-PHASE LIQUID CHROMATOGRAPHY.
Turin Univ. (Italy). Dipt. di Chimica Analitica.
For primary bibliographic entry see Field 5A.
W91-07368

RECENT DISTRIBUTION OF GLACIAL RELICT MALACOSTRACA IN THE WESTERN AND SOUTHERN BALTIC.
Rostock Univ. (German D.R.). Sektion Wirtschaftswissenschaften.
J. Kohn.
Annales Zoologici Fennici AZOFAO, Vol. 27, No. 3, p 231-235, December 1990. 3 fig, 1 tab, 28 ref.

Descriptors: *Aquatic animals, *Baltic Sea, *Crustaceans, *Eutrophication, *Lakes, *Water pollution effects, Amphipods, Distribution patterns, Ecological distribution, Mollusks, Opossum-shrimp, Population density.

A knowledge of the distribution of glacial relicts (mollusks and malacostracans) permits one to draw conclusions about environmental conditions in different regions below the thermocline, especially in relation to the oxygen content of the near bottom water. Data lists of benthos monitoring and cod gut analyses were used to check the recent distribution of Mysis relicta, Saduria entomon, Pontoporeia affinis, and P. femorata in the western and southern Baltic. Eutrophication and the shortness of periods with a sufficient oxygen concentration in the deep water may have affected the distribution and frequency of glacial relict malacostracans. Nevertheless, immigration into formerly 'dead areas' for glacial relicts is much more difficult now due to the eutrophication of large intervening areas. The mode of immigration has to be changed as the passage through the deep basins is now either impossible or of minor importance. A route must be taken parallel to the coasts, avoiding the deeper areas. Thus the distances are much longer and the time needed for returning increases in contrast to the shorter periods of favorable conditions in the western and southern Baltic. The consequences are seen in the present lower frequencies of occurrence. (Doria-PTT)
W91-07372

PERSPECTIVES ON THE ECOLOGICAL FACTORS REGULATING PONTOPOREIA POPULATIONS IN THE NORTHERN BALTIC SEA.
Tvarminne Zoological Station (Finland).
A. Uitto, and J. Sarvala.
Annales Zoologici Fennici AZOFAO, Vol. 27, No. 3, p 297-301, December 1990. 2 fig, 23 ref.

Descriptors: *Amphipods, *Animal populations, *Baltic Sea, *Benthic fauna, *Marine biology, *Physiological ecology, Aquatic populations, Bacteria, Carbon, Detritus, Finland, Food chains, Food habits, Growth, Life cycles, Predation, Salinity, Sediments, Temperature.

The deposit-feeding amphipods Pontoporeia affinis and P. femorata are the dominant macrobenthic animals in deep soft bottom areas of the northern Baltic Sea. Their abundance, growth, and life cycle vary according to local temperature and food conditions. Both species seem to be food-limited. In the Tvarminne area, on the southwest coast of Finland, the seasonal timing of growth differs between species, indicating either competition or differing food sources. Abiotic and biotic factors regulating Pontoporeia populations make up an intertwined network, with numerous one-way effects and two-way interactions. For example, temperature and salinity limit the distribution of Pontoporeia, and temperature also directly affects the rates of feeding, respiration, and growth; however, because of complicated food web effects, the overall influence of temperature, as of any single factor, is difficult to evaluate. The onmivory of Pontoporeia on three successive levels (sediment detrital carbon, bacteria, and meiofauna) confuses predator-prey and competitive relationships in the detritus-based benthic system. Calculations based on the observed growth and production show that Pontoporeia species must obtain most of their energy requirements from detrital carbon. Nonselective feeding by Pontoporeia decreases the populations of bacteria and the meiofauna, and thus probably releases Pontoporeia from their competition for the detrital carbon source, but at the same time decreases the availability of high quality food. (Author's abstract)
W91-07375

KHNIFISS LAGOON AND ADJACENT DESERT AREA: GEOGRAPHICAL DESCRIPTION AND RECENT COASTLINE CHANGES.
Institut Scientifique, Rabat (Morocco). Dept. de Zoologie et Ecologie Animale.
M. Dakki, and D. M. Parker.
Trav. Inst. Sci. Rabat, Mem. Hors Serie, p , 1988.

Descriptors: *Biogeography, *Coastal lagoons, *Deserts, *Morocco, *Sahara, Arid zone, Coasts, Geography, Geology, Geomorphology, Khnifiss Lagoon, Lagoons, Mud flats, Salt marshes, Sandbars, Topography, Water currents.

The topography of the coast and hinterland of the Moroccan Sahara between Tarfaya and Akhfennir is briefly described and discussed, with accounts of the geology and development of the region. This arid and semi-arid coastal area is in the full desert zone of the oceanic Sahara. It connects the biogeographical zone of the Mediterranean with the savanna (tropical) zone. Elements of Mediterranean and tropical fauna and flora occur in the area. However, the coastal Sahara contains endemic species whose world distribution is confined to this zone. In addition, the project area is unique in the Moroccan Sahara in that the Khnifiss Lagoon is the only example of a substantial inland marine environment with intertidal mudflats and salt marshes. It is important to understand that the Khnifiss Lagoon has undergone considerable changes in geological and historical time. Evidence would suggest that the Khnifiss environment is continually undergoing modification, mainly due to the large amounts of moving sand that are present. The mud and sandbanks in the lagoon are also constantly shifting their position and this may be linked with seasonal changes at the mouth of the lagoon. (See also W91-07406 thru W91-07412)(Doria PTT)
W91-07405

KHNIFISS LAGOON AND ADJACENT WATERS: HYDROLOGY AND HYDRODYNAMICS.
Institut Scientifique, Rabat (Morocco). Dept. de Zoologie et Ecologie Animale.
M.-A. El Agbani, M. Fekhaoui, A. Bayed, and J. Schouten.
Trav. Inst. Sci. Rabat, Mem. Hors Serie, p 17-26, 1988. 13 fig, 2 tab, 10 ref.

Descriptors: *Coastal lagoons, *Hydrodynamics, *Hydrology, *Morocco, Acidity, Chemical properties, Conductivity, Dissolved oxygen, Hypersalinity, Khnifiss Lagoon, Mixing, Neap tides, Physical properties, Salinity, Spring tides, Temperature, Tidal effects, Water currents, Water level.

The hydrology and hydrodynamics of the Khnifiss Lagoon (Morocco) were studied using 7 environmental parameters (water level, speed of current, salinity, conductivity, dissolved oxygen, temperature, and pH). Because the lagoon opens out into the Atlantic, its hydrodynamic and thermal features are closely bound up with tidal movements. The Khnifiss Lagoon undergoes the influence of two tidal cycles every 24 hours. This influence is felt up to more than 20 k inland. The tidal lag becomes greater towards the interior of the lagoon. The lag is at its minimum during neap tides and at its maximum during spring tides. These tides are the predominant influence on the principal physical parameters of the lagoon. With each tidal cycle, the waters of the lagoon are renewed, following a mixing of the layers of lagoon and ocean water. When the lagoon is filling, this mixing results in a reduction of temperature and salinity in the lagoon water. The incoming tide covers part of the Sebkha Tazra and the salinity increases upon contact with the saline substratum. Only the seaward third of the lagoon consists of euhaline water, the remaining two thirds being composed of hypersaline water. With regard to the preservation of the natural conditions of the Khnifiss Lagoon, it is essential that not only the surrounding ocean but also Sebkha Tazra be preserved, since the sebkha could become a possible zone of irreversible contamination for the lagoon. (Doria-PTT)
W91-07406

KHNIFISS LAGOON AND ADJACENT WATERS: CHEMISTRY OF THE SURFACE WATERS.
Institut Scientifique, Rabat (Morocco). Dept. de Zoologie et Ecologie Animale.
M. Fekhaoui, M. A. El Agbani, and A. Bayed.
Trav. Inst. Sci. Rabat, Mem. Hors Serie, p 27-35, 1988. 11 fig, 3 tab, 9 ref.

Descriptors: *Chemical properties, *Coastal lagoons, *Ecological distribution, *Khnifiss Lagoon, *Morocco, Alkalinity, Birds, Buffering, Carbonates, Chlorophyll, Eutrophication, Nitrogen compounds, Nutrients, Organic carbon, Orthophosphates, Particulate matter, Phosphates, Physical properties, Salts, Seasonal variation, Spatial distribution.

The surface waters of the Khnifiss Lagoon (Morocco) and the adjacent areas underwent bimonthly analysis at 7 stations between August 1985 and April 1986 for alkalinity, carbonates, orthophosphates, nitrogen compounds, particulate organic carbon, and chlorophyll pigments. The variations recorded revealed a well-buffered environment, enriched with nutrient salts, particularly phosphates at the bottom of the lagoon and high levels of particulate organic carbon. Separate zones differentiated mainly by their oceanic influences were also evident; these influences govern the quality of the surface waters of this lagoon system. The oceanic waters demonstrate great chemical stability over time due to a buffering effect. The zone of water with significant oceanic influence displays physical and chemical stability and is favorable to the establishment of an abundant and highly diversified fauna that can be utilized in particular by

birds. The chemical characteristics of waters with slight oceanic influence show significant periodic fluctuations during the year, indicating much greater biological activity than in the other zones; the heterogeneity of chemical composition and the occurrence of unfavorable conditions resulting from decomposition of organic material probably lead to reduction in the species diversity of bottom-dwelling fauna, producing unfavorable nutritive conditions for birds. Waters without oceanic influence have a tendency to eutrophication. (Doria-PTT)
W91-07407

SEAWEEDS OF THE KHNIFISS LAGOON AND THE TARFAYA COAST.
Liverpool Univ. (England). Dept. of Botany.
G. Russell, and D. Hockin.
Trav. Inst. Sci. Rabat, Mem. Hors Serie, p 37-40, 1988. 3 fig, 1 tab, 5 ref.

Descriptors: *Algae, *Coastal lagoons, *Ecological distribution, *Intertidal areas, *Khnifiss Lagoon, *Morocco, *Physiological ecology, Algal physiology, Chlorophyta, Fucus, Phaeophyta, Rhodophyta.

A survey of the coastal algae of the Tarfaya region and the Khnifiss Lagoon (Morocco) was conducted because of the importance of seaweed communities in rocky tidal environments. A collection of marine algae recorded four species of Chlorophyta, ten species of Phaeophyta, and 17 species of Rhodophyta. The majority of species were limited in their distribution by the occurrence of rocky outcrops in the intertidal and subtidal zones. A number of epiphytic genera of algae were recorded from the Zostera growing in the Khnifiss Lagoon. Also present in the hypersaline lagoon was Fucus vesiculosus; the Lagoon is the most southerly site where this species is recorded. The physiological difference between the Moroccan material and more typical northern Atlantic material was examined. It is very likely that the British Fucus transplanted to the Khnifiss Lagoon would experience conditions that would cause considerable damage to its photosynthetic system. Some physiological differences between the populations may have evolved in response to very different environmental conditions. The Moroccan lagoon population of F. vesiculosus is therefore of considerable scientific importance. (Doria-PTT)
W91-07408

MEIOFAUNAL COPEPODS AND NEMATODES OF THE KHNIFISS LAGOON AND THE TARFAYA COAST.
Liverpool Univ. (England). Environmental Advisory Unit.
D. C. Hockin.
Trav. Inst. Sci. Rabat, Mem. Hors Serie, p 65-69, 1988. 2 fig, 3 tab, 8 ref.

Descriptors: *Coastal lagoons, *Copepods, *Ecological distribution, *Intertidal areas, *Khnifiss Lagoon, *Marine biology, *Morocco, *Nematodes, Biogeography, Coastal waters, Ecology, Food habits, Hypersaline water, Mud flats, Sandbars, Sediments.

A series of samples of intertidal sandbanks and mudflats from the marine coastal waters of Tarfaya and from the hypersaline waters of the Khnifiss Lagoon (Morocco) contained 18 species of harpacticoid copepod. The fauna comprises eastern Atlantic, Mediterranean, and northern African components. In the coarse coastal sediments mesopsammic and endopsammic species predominated, while endopsammic species were most abundant in the sandy sediments of the lagoon, especially in the extremely hypersaline waters and epipsammic species were most numerous in the silt deposits. The known Moroccan harpacticoid copepod fauna is listed. In the high energy coastal sediments the nematode fauna was dominated by omnivorous species with strongly developed and modified mouthparts, while in the more sheltered lagoon epigrowth feeders predominated in the sandy sediments and non-selective deposit feeders were most abundant in the muddy sediments. (Author's abstract)
W91-07409

BENTHOS OF SOFT SUBSTRATES IN THE INTERTIDAL ZONE OF THE KHNIFISS LAGOON.
Institut Scientifique, Rabat (Morocco). Dept. de Zoologie et Ecologie Animale.
A. Bayed, M.-A. El Agbani, M. Fekhaoui, and J. Schouten.
Trav. Inst. Sci. Rabat, Mem. Hors Serie, p 71-80, 1988. 11 fig, 7 tab, 19 ref.

Descriptors: *Benthic fauna, *Coastal lagoons, *Intertidal areas, *Khnifiss Lagoon, *Marine biology, *Morocco, Crustaceans, Ecological distribution, Ecology, Polychaetes, Population density, Sand, Species composition, Species diversity.

A study of benthos in the soft bottom intertidal zone of the Khnifiss Lagoon (Morocco) was conducted between June 1985 and April 1986 using 5 stations spread over a distance of approximately 17 km. The correspondence analysis revealed 3 communities related to fine silty sands, fine sands, and compact fine sands. Changes over a period of time in the species abundance and richness were analyzed at the 5 stations; variations in abundance were revealed by those of pilot species. The spatial approach showed that the largest number of species was found in the middle lagoon environment, while the mean density was gradually progressing from the mouth of the lagoon to the station situated furthest from the sea. Here, the harshness of the environment meant that species of crustaceans and polychaetes were unable to become established in large numbers. However, the Khnifiss Lagoon does have a greater diversity and abundance of macrofauna than other lagoons in Morocco. (Author's abstract)
W91-07410

INFRALITTORAL EPIFAUNAL COMMUNITIES OF THE KHNIFISS LAGOON AND THE ADJACENT COAST.
Institut Scientifique, Rabat (Morocco). Dept. de Zoologie et Ecologie Animale.
M. Menioui.
Trav. Inst. Sci. Rabat, Mem. Hors Serie, p 81-85, 1988. 3 tab, 13 ref.

Descriptors: *Coastal lagoons, *Ecological distribution, *Khnifiss Lagoon, *Littoral environment, *Marine animals, *Marine biology, Algae, Aquatic animals, Biogeography, Coastal environment, Crustaceans, Mollusks, Morocco, Polychaetes, Sea grasses, Species composition, Surveys.

A study was undertaken of the fauna of 4 infralittoral epifaunal communities identified on the rocky coast between the Khnifiss Lagoon and the town of Tarfays (Morocco) and a Zostera bed identified in the Khnifiss Lagoon which was separated into a surface area and a bottom area. The 4 infralittoral communities are dominated by Jania rubens, Mytilus edulis, Ulva rigida, and Cystoseira sp., respectively. Study of these communities revealed 142 species including 74 crustaceans, 50 mollusks, and 18 polychaetes. The species identified in the lagoon are, for the most part, either those which prefer the lagoon environment or those that are typical of the shifting substrate, whereas those identified in the marine zone are more widespread generally. From a biogeographical point of view, this study made it possible to identify several species new to Tarfaya. Some of these were new to Morocco altogether whereas, for some, Tarfaya marked the new southernmost limit of their range. (Author's abstract)
W91-07411

MANAGED AQUATIC ECOSYSTEMS.
For primary bibliographic entry see Field 6A.
W91-07417

MANAGED COASTAL WATERS FOR OYSTER CULTURE IN JAPAN.
National Research Inst. of Aquaculture, Mie (Japan). Fish Nutrition Div.
For primary bibliographic entry see Field 8I.
W91-07423

FORESTED WETLANDS.
For primary bibliographic entry see Field 2H.
W91-07424

FRINGE WETLANDS.
Institute of Tropical Forestry, Rio Piedras, PR.
A. E. Lugo.
IN: Forested Wetlands. Ecosystems of the World, 15. Elsevier Science Publishing Co., New York. 1990. p 143-169. 12 fig, 9 tab, 72 ref.

Descriptors: *Caribbean, *Florida, *Mangrove swamps, *Reviews, *Vegetation, *Wetland forests, *Wetlands, Aquifer discharge, Ecosystems, Estuaries, Eutrophication, Fringe wetlands, Hydrologic energy, Hydroperiod, Lakes, Oil pollution, Runoff, Seiches, Swamps, Tides, Waves, Zonation.

Fringe wetlands are characterized by the dominance of few species, a clear species zonation, synchrony of ecological processes with episodic events, and simplicity in the structure of vegetation. The structure and ecosystem dynamics of fringe forested wetlands are presented with emphasis on saltwater wetlands because they have been studied more than freshwater ones. The study areas were Caribbean and Florida mangroves. Fringe wetlands are found on the water edge of oceans, inland estuaries, and lakes. Water motion in the fringe is bi-directional and perpendicular to the forest and due mostly to tidal energy in oceanic and estuarine fringes. In lakes, water moves in and out of the fringe under the influence of wind, waves, or seiches. Some fringe forests are occasionally flushed by terrestrial runoff or aquifer discharge. In contrast, fringe forests located on small offshore islands or steep coastal shores are isolated from terrestrial runoff or aquifer discharge, and their hydroperiod is controlled by tides and waves only. Literature reviews suggest that ecosystem parameters such as vegetation structure, tree growth, primary productivity, and organic matter in sediments respond proportionally to hydrologic energy. Human activity that impacts on fringe forested wetlands include harvesting of trees, oil pollution and eutrophication. (See also W91-07424) (Medina-PTT)
W91-07429

STRUCTURE AND DYNAMICS OF BASIN FORESTED WETLANDS IN NORTH AMERICA.
Illinois Univ. at Urbana-Champaign. Dept. of Forestry.
For primary bibliographic entry see Field 2H.
W91-07430

PALM SWAMPS.
American Museum of Natural History, Lake Placid, FL. Archbold Biological Station.
R. L. Myers.
IN: Forested Wetlands. Ecosystems of the World, 15. Elsevier Science Publishing Co., New York. 1990. p 267-286. 9 fig, 8 tab, 65 ref, append.

Descriptors: *Costa Rica, *Palm trees, *Swamps, *Tropical areas, *Wetland forests, *Wetlands, Fire, Flooding, Hydroperiod, Literature review, Rainfall, Species composition, Vegetation, Water level.

Palms are the dominant plant life forms in many tropical wetlands, and dominance by palms frequently increases with increasing hydroperiod. In such cases, flooding and fire act in concert to produuce palm-dominated forests. The first part of this review describes three major categories of palm-dominated swamps: monospecific swamps, species-rich swamps, and seasonal swamps. Palm swamps are largely unstudied, descriptions in the literature are sparse, and what is presented here is more than likely only a portion of what concerns palm swamp types, their areal extent, and species involved. The second part includes detailed descriptions and data on the structue of palm swamps in Costa Rica, dominated by Raphia taedigera and Namicaria saccifera. An appendix on the methods used for observations of rainfall, water level and vegetation is included. (See also W91-07424) (Medina-PTT)

W91-07434

FORESTED WETLANDS OF MEXICO.
Universidad Nacional Autonoma de Mexico, Mexico City. Inst. de Biologia.
A. Lot, and A. Novello.
IN: Forested Wetlands. Ecosystems of the World, 15. Elsevier Science Publishing Co., New York. 1990. p 287-298. 9 fig, 1 tab, 31 ref. National Ecology Program of the CONACYT Project PCECNAL-790236.

Descriptors: *Mangrove trees, *Mexico, *Swamps, *Wetland forests, *Wetlands, Arid zone, Riparian vegetation, Semiarid climates, Shrubs, Soil properties, Topography, Trees, Tropical regions, Vegetation.

Most forested wetlands in Mexico are concentrated in the coastal plain of southern Veracruz, Tabasco and Campeche. Mangroves and riverine forests extend over large areas, but other wetland types cover small areas. Herbaceous wetlands are important further north the Tampico region towards the state of Tamaulipas, in the Pacific coastal plain of Nayarit, and in northern Michoacan to the canter of Jalisco. Riparian forests extend from sea level to about 2800 m elevation, with species of Populus predominating in arid and semi-arid regions of northern Mexico and species of Alnus in more temperate zones with cooler climates. Trees of the genus Asianthus grow along lowland river courses with long dry seasons, while in moist and wet regions, Bambusa, Ficus, Inga and Pachira are predominant. The focus of this review is on the tropical lowland region of southern Veracruz, Tabasco, and Campeche, the region of Mexico where forested wetlands have been most studied. Elevations in these wetland regions do not exceed 40 m, topographic relief is slight, and well developed fluvial systems such as those of the Grijalva-Usumacinta river deltas are typical. Vegetation profiles and soil characteristics are given for high forested wetlands, low forested wetlands and shrub wetlands . (See also W91-07424) (Medina-PTT)
W91-07435

OLIGOTROPHIC FORESTED WETLANDS IN BORNEO.
Hamburg Univ. (Germany, F.R.). Inst. of World Forestry.
E. F. Bruenig.
IN: Forested Wetlands. Ecosystems of the World, 15. Elsevier Science Publishing Co., New York. 1990. p 299-334. 27 fig, 56 ref.

Descriptors: *Borneo, *Forests, *Oligotrophy, *Swamps, *Wetland forests, *Wetlands, Agriculture, Brunei, Ecology, Humid climates, Mineral soils, Nutrients, Peat soils, Sarawak, Silviculture, Species diversity, Vegetation, Waterlogging.

Borneo, the third largest island in the world has a long history of uninterrupted evolution under conditions which combined excellent suitability for growth with a high degree of geological and geomorphic heterogeneity. The warm and humid, only weakly seasonal but periodically variable and episodically extreme climate favors the development and maintenance of an extremely high species richness and diversity of the vegetation at three levels: within the stand, between stands, and between geographical landscape and regional units. Unique within this island are the forested oligotrophic rain-flooded wetlands which occupy areas which may be small and scattered, or very extensive, continuous tracts of land, and occur on a great variety of sites and substrates. During the 1950s, extensive, quantitative and comprehensive ecological studies were made in the dipterocarp forests of Brunei and Sarawak. Two major subdivisions of forests were also distinguished: the kerangas forests on mineral soils and forests on wet, peaty soil for which the name kerapah was adopted. Presently, there are two major formations of oligotrophic forested wetlands in the forests and one comparable formation in the montane zone of Borneo. All three formations are characterized by extreme, but interrupted, waterlogging and low levels of mineral nutrient availability. The two oligotrophic wetland formations in the lowlands are the coastal or deltaic peat-swamp forests and the kerapah forests. In hollows, a trend toward kerapah was noticeable. Agricultural use of shallow peats has been successful. More recently, intensive and mechanized commercial timber exploitation has resulted in a complete change in the forest structure, and a drastic shift of species composition in favor of species which are tolerant to sudden change. (See also W91-07424) (Medina-PTT)
W91-07436

ENVIRONMENT AND ECOLOGY OF FORESTED WETLANDS OF THE SUNDARBANS OF BANGLADESH.
University Staff Quarters, 16/A Fullar Road, Ramna, Dhaka-2, Bangladesh.
M. Ismail.
IN: Forested Wetlands. Ecosystems of the World, 15. Elsevier Science Publishing Co., New York. 1990. p 357-386. 4 fig, 14 tab, 49 ref, append.

Descriptors: *Bangladesh, *Mangrove swamps, *Sundarbans, *Swamps, *Water resources management, *Wetland forests, *Wetlands, Drought, Ecosystems, Flora, Monsoons, Nutrients, Plant populations, Rainfall, Salinity, Sediment transport, Snowmelt, Spring tides, Tidal bores.

Bangladesh is located in the south slope of the world's highest mountain and along the northern extremity of the Bay of Bengal. Its abundance of large rivers, rainfall, flora, and fauna make it ecologically significant. There is an extensive mangrove forest of the Sundarbans with many endangered species, highly interwoven river systems and large tracts of wetlands with rich avifauna. Its tidal woodlands occupy an area of about 78,000 sq km, the world's most extensive single tract of mangrove. This area is fed by snowmelt as well as heavy monsoonal rainfall. A large amount of sediment is transported by an annual runoff of about 1357 sq km from a catchment area of more than 1.6 million sq km. Nutrients contributed from the Bay of Bengal enter the Sundarbans with the tides and mix with upland runoff to form a rich interface of brackish water. The environment oscillates between salt and freshwater, and between excess water at high spring tides during the monsoon season and drought conditions during the long dry season. The Sundarbans are an unusual mangrove ecosystem. The forests are flushed year-round with upland river water, and salinity remains relatively low. A dominant plant species, Heritiera fomes, a low salinity species practically unknown in mangrove forests elsewhere in the world, is dominant in the northeastern part of the forest where salinity is lowest. All plant species appear to be distributed according to long-term salinity patterns influenced by tidal inundations with the exception of nipa palm (Nipa fruticans) which occurs predominantly in the most frequently inundated, low-salinity areas along the river banks. The Sundarbans forest is used for recreation and provides ideal habitat for a great variety of fish and game animals. The mangrove forests are also significant in mitigating tidal bores and many other environmental hazards in the cyclone-prone monsoon region. The currently deteriorating Sundarbans needs afforestation of newly-formed land and management of this important forest region. (See also W91-07424) (Medina-PTT)
W91-07438

FORESTED WETLANDS IN AUSTRALIA.
Queensland Univ., Brisbane (Australia). Dept. of Botany.
For primary bibliographic entry see Field 2H.
W91-07439

FORESTED WETLANDS IN WESTERN EUROPE.
For primary bibliographic entry see Field 2H.
W91-07440

SYNTHESIS AND SEARCH FOR PARADIGMS IN WETLAND ECOLOGY.
Institute of Tropical Forestry, Rio Piedras, PR.
For primary bibliographic entry see Field 2H.
W91-07442

HYDRODYNAMIC SIMULATION OF THE UPPER ESTUARY OF THE ST. LAWRENCE RIVER (CANADA) WITH A DRYING AND WETTING FINITE ELEMENTS MODEL (SIMULATION HYDRODYNAMIC DE L'ESTUAIRE SUPERIEUR DU FLEUVE SAINT-LAURENT (CANADA) AVEC UN MODELE AUX ELEMENTS FINIS COUVRANT-DECOUVRANT).
INRS-Eau, Sainte-Foy (Quebec).
M. Leclerc, J. F. Bellmare, and S. Trussard.
Canadian Journal of Civil Engineering CJCEB8, Vol. 17, No. 5, p 739-751, October 1990, 11 fig, 1 tab, 27 ref. English summary.

Descriptors: *Computer modeling, *Estuaries, *Finite element method, *Hydrodynamics, *Model studies, *St Lawrence River, Boundary processes, Canada, Model testing, Simulation analysis, St Venant equation, Tidal currents.

A two-dimensional finite element hydrodyanmic model with moving boundaries for the action of the tides (drying/wetting) was prepared for the Saint Lawrence River between Lobiniere and the Sainte-Anne-de-la-Perade. The model is presented as a cheap and reliable alternative to intensive hydrographic field survey. Each segment of the river has many problems which are peculiar to that part of the river. There are the rapids of the Lachine and Richelieu and the large eddy of Lac Saint Pierre. The river currents between Lac Saint Pierre and the Ile d'Oleans are influenced by the actions of both tides, run-off and wind. Also the acquisition of data is complicated by the extreme variability of the survey parameters. At Portneuf, the reversal of the tides is described by a semi-diurnal cycle with an amplitude which varies with the lunar and solar cycles. Upstream at Batiscan, the tidal reversal occurs occasionally, and depends on the river discharge which is seasonal. These factors cause survey work to be elaborate. The model presented here was based on the equations of Saint-Venant. The model was calibrated against observations made on October 25th, 1986. The river level was sampled at five diverse sites. The vertically integrated velocity was measured, and the residual discharges were estimated. The model was validated by comparing measured and calculated values for velocity, river level and residual discharge. (King-PTT)
W91-07524

MATHEMATICAL MODELING OF HYDRODYNAMICS AND MOVEMENT OF POLLUTION IN A LAGOON SYSTEM (MODELISATION MATHEMATIQUE DE L'HYDRODYNAMIQUE ET DU MOVEMENT DE LA POLLUTION EN SYSTEME LAGUNAIRE).
BCEOM-Service Hydraulique, 259 Avenue de Melgueil, 34280 La Grande Motte, France.
For primary bibliographic entry see Field 5B.
W91-07529

VARIATION BEHAVIOUR OF TIDAL STAGES IN CHANGJIANG RIVER ESTUARY AND ITS ENGINEERING SIGNIFICANCE (IN CHINESE).
For primary bibliographic entry see Field 8B.
W91-07537

INFLUENCE OF BIODEPOSITION BY FILTER-FEEDING BIVALVES ON THE MIOBENTHIC POPULATIONS OF A MARITIME MARSH (INFLUENCE DE LA BIODEPOSITION DE BIVALVES FILTREURS SUR LESE PEUPLEMENTS MIOBENTHIQUES D'UN MARAIS MARITIME).
Centre de Recherche en Ecologie Marine et Aquaculture, Nieul sur Mer (France).
For primary bibliographic entry see Field 2J.
W91-07560

ANAEROBIC BIODEGRADATION OF SKELETAL STRUCTURES IN THE MARINE ENVIRONMENT: II. CHEMICAL ASPECTS (BIODE-

GRADATION ANAEROBIQUE DES STRUCTURES SQUELETTIQUES EN MILIEU MARIN : II. APPROCHE CHIMIQUE).
Liege Univ. (Belgium). Zoology Inst.
For primary bibliographic entry see Field 2K.
W91-07561

PROTOZOA ABUNDANCE, GROWTH, AND BACTERIOVORY IN THE WATER COLUMN, ON SEDIMENTING PARTICLES, AND IN THE SEDIMENT OF HALIFAX HARBOR.
Dalhousie Univ., Halifax (Nova Scotia). Dept. of Biology.
For primary bibliographic entry see Field 2J.
W91-07563

ANTIBIOTIC RESISTANCE INDEXING OF ESCHERICHIA COLI TO IDENTIFY SOURCES OF FECAL CONTAMINATION IN WATER.
Maryland Univ., College Park. Dept. of Microbiology.
For primary bibliographic entry see Field 5B.
W91-07564

INTEGRAL EQUATION SOLUTION FOR THE BREAKWATER GAP PROBLEM.
Canterbury Univ., Christchurch (New Zealand). Dept. of Civil Engineering.
B. Hunt.
Journal of Hydraulic Research JHYRAF, Vol. 28, No. 5, p 609-619, 1990. 6 fig, 7 ref.

Descriptors: *Breakwaters, *Harbors, *Hydraulic engineering, *Model studies, *Waves, Flow pattern, Hydraulic structures, Wave height, Wavelengths.

Solutions for the movement of waves through a breakwater gap are useful for calculating gap widths that will reduce wave amplitudes within harbors to acceptable levels. The problem of waves passing through a gap in an infinitely long breakwater was reduced to the solution of a Fredholm integral equation of the first kind. Wave amplitudes across the gap were shown to exactly equal incident wave amplitudes, but wave amplitudes throughout the remainder of the flow must be calculated numerically. Solution accuracy was easily checked by comparing solutions for several different boundary node spacings, and it was suggested that this method appears to give results that are easier to calculate and are more accurate than previously calculated solutions. (Author's abstract)
W91-07601

ECOPHYSIOLOGICAL AND TROPHIC IMPLICATIONS OF LIGHT-STIMULATED AMINO ACID UTILIZATION IN MARINE PICOPLANKTON.
North Carolina Univ. at Chapel Hill. Inst. of Marine Sciences.
H. W. Paerl.
Applied and Environmental Microbiology AEMIDF, Vol. 57, No. 2, p 473-479, February 1991, 4 fig, 1 tab, 34 ref.

Descriptors: *Amino acids, *Bacterial physiology, *Cyanophyta, *Food chains, *Nitrogen cycle, *Phototropism, *Physiological ecology, *Phytoplankton, Chlorophyll a, Light effects, Marine bacteria, Nitrogen compounds, Primary productivity.

By using microautoradiography, light-stimulated utilization of dissolved amino acids for natural marine phytoplankton assemblages was demonstrated. The <2 micron-size diameter picoplankton, known to be a dominant fraction of marine primary production, revealed a widespread capability for this process. Autofluorescent (chlorophyll a-containing) picoplankton and some larger phytoplankton from diverse oceanic locations, as well as isolates of the representative cyanobacterial picoplankton Synechococcus (WH7803, WH8101), showed light-stimulated incorporation of amino acids at trace concentrations. Dark-mediated amino acid utilization was dominated by nonfluorescent bacterial populations. Among autofluorescent picoplankton, light-stimulated exceeded dark-mediated amino acid incorporation by 5 to 75%; light-stimulated amino acid incorporation was only partially blocked by the photosystem II inhibitor 3(3,4-dichloro-phenyl)-1,1-dimethylurea (0.00002 M), suggesting a photoheterotrophic incorporation mechanism. Parallel light versus dark incubations with glucose and mannitol indicated a lack of light-stimulated utilization of these nonnitrogenous compounds. Since marine primary production is frequently nitrogen limited, light-mediated auxotrophic utilization of amino acids and possibly other dissolved organic nitrogen (DON) constituents may represent exploitation of the relatively large DON pool in the face of dissolved inorganic nitrogen depletion. This process (1) increases the efficiency of DON retention at the base of oceanic food webs and (2) may in part be responsible for relatively high rates of picoplankton production under conditions of chronic dissolved inorganic nitrogen limitation. Picoplankton recycling of organic matter via this process has important ramifications with respect to trophic transfer via the 'microbial loop'. (Author's abstract)
W91-07653

WETLANDS: MITIGATING AND REGULATING DEVELOPMENT IMPACTS.
Urban Land Inst., Washington, DC.
D. Salvesen.
The Urban Land Institute, Washington, DC. 1990. 117p, 23 fig, 55 ref, append.

Descriptors: *Environmental protection, *Regulations, *Water resources development, *Wetland mitigation, *Wetlands, Federal jurisdiction, Standards, State jurisdiction, Wetland enhancement, Wetland restoration.

Throughout history, people have altered wetlands to create harbors, control mosquitoes, expand farmland, and provide home-sites. Despite developers' best efforts to steer clear of wetlands, more filling is bound to occur as communities seek room to grow. Several communities rely on special area management plans to shunt development away from high quality wetlands and to provide developers with a more predictable permit process. States have also been active in protecting wetlands. Over the last 10-15 years, several states have adopted their own wetlands protection laws. Typically broader and stricter than their federal counterparts, state wetlands laws cover more than just dredging and filling and include, for example, draining and excavation. In addition, several states have developed wetlands acquisition programs. At the national level, the trend of expanding federal jurisdiction over wetlands is likely to continue. And with their newfound authority to issue administrative penalties, both EPA and the Corps of Engineers will be more likely to pursue and fine wetlands scofflaws. While federal, state, and local agencies and governments work to establish mitigation standards, ongoing wetlands research projects may shed new light on different mitigation techniques and help eliminate some of the current uncertainties associated with creating new wetlands. The results of these and other projects, however, will not be forthcoming for several years. In the meantime, development marches on and new discoveries about wetlands restoration and creation will continue to arise from developer-sponsored mitigation projects. In some parts of the country, off-site mitigation sites have become a scarce commodity. Mitigation banking, though, offers one possible solution to this dilemma. Despite some initial setbacks, mitigation banks will probably become more popular, both because of their convenience and also because they provide a reasonable solution to the problem of mitigating small, isolated wetland fills. For the moment, those who are considering developing in wetlands should bear three things in mind: (1) Location counts. Many state and local governments have enacted their own wetland laws, which vary in stringency; (2) Abide by the rules; and (3) Approvals far exceed denials. As a whole, the nation still favors development over preservation of wetlands--judged, at least, by the laws and programs designed to regulate development in wetlands. (Lantz-PTT)
W91-07807

NITROGEN DYNAMICS IN THE TIDAL FRESHWATER POTOMAC RIVER, MARYLAND AND VIRGINIA, WATER YEARS 1979-81: A WATER-QUALITY STUDY OF THE TIDAL POTOMAC RIVER AND ESTUARY.
D. J. Shultz.
Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Water-Supply Paper 2234-J, 1989. 41p, 20 fig, 10 tab, 70 ref.

Descriptors: *Estuaries, *Maryland, *Nitrates, *Nitrogen cycle, *Potomac River, *Tidal rivers, *Virginia, Ammonia, Denitrification, Nitrification, Nitrogen, Phytoplankton, Seasonal variation.

On an annual basis, river supplied nitrate is the predominant form of N supplied to the tidal Potomac River from external sources. Much of the nitrate is associated with high flows that have rapid transit times through the tidal river. After the fall of 1980, initiation of advanced wastewater treatment at the Blue Plains Sewage Treatment Plant (STP) reduced ammonia loading to the river by 90% and increased nitrate loading by a similar percentage. As a result, concentrations of ammonia during the 1981 low flow period were < 0.20 mg/L as N at Alexandria, while nitrate concentrations were > 1.50 mg/L as N. Despite the reduced availability of ammonia, 15-N uptake studies showed that phytoplankton preferred ammonia to nitrate unless ammonia concentrations were < 0.10 mg/L as N. Nitrification studies during 1981 using a 14-C uptake technique indicate that rates did not vary with sample location, except for one sample from the head of the tidal river, where the rates were much higher. Process models were used in conjunction with mass-balance determinations and individual process studies to estimate rates of processes that were not directly measured. It is estimated that denitrification removed 10 times as much nitrate from the water column during the summer of 1981 as during the summer of 1980. Sedimentation of particulate N is estimated to be the largest sink for N from the water column and was approximately equal to the external annual loading of all N constituents on a daily basis. In summer, when river flows usually are low, the tidal Potomac River appears to be a partially closed system rather than one dominated by transport. Nitrogen constituents, primarily from point sources, are taken up by phytoplankton converted to organic matter, and sedimented from the water column. Some of this N eventually becomes available again by means of benthic exchange. Removal, by transport, out of the tidal river is significant only during winter. (Lantz-PTT)
W91-07822

NUMERICAL MODELLING OF SUSPENDED SEDIMENT FLUXES IN ESTUARINE WATERS.
Bradford Univ. (England). Dept. of Civil Engineering and Structural Engineering.
R. A. Falconer, and P. H. Owens.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 31, No. 6, p 745-762, December 1990. 11 fig, 4 tab, 23 ref.

Descriptors: *Erosion, *Estuarine sediments, *Finite difference methods, *Model studies, *Sediment transport, *Suspended sediments, Coastal engineering, Deposition, England, Estuaries, Humber Estuary, Model testing, Tidal currents, Turbulent flow.

A two-dimensional finite difference numerical model, capable of predicting depth-averaged tidal flow fields in coastal and estuarine waters, was extended to include tide-induced non-cohesive sediment transport processes. The partial differential equations governing the conservation of mass, momentum, and suspended sediment in an incompressible turbulent flow are included in a depth-integrated form of the model. For the representation of the processes of erosion and deposition of sediment from the bed, an empirically based source-sink term was refined, based on the results of three mobile bed flume studies. The model was tested by simulating tidal flows and suspended sediment fluxes in two estuaries, with particular

application to the Humber estuary in England. The model was calibrated and found to produce an encouraging degree of agreement between the numerical predictions and corresponding field measurements for the estuary. The predicted gross deposition and erosion features of the estuary were in close agreement with interpretations from Eulerian tidal residual predictions. (Author's abstract)
W91-07861

ACETATE IN RECENT ANOXIC SEDIMENTS: DIRECT AND INDIRECT MEASUREMENTS OF CONCENTRATION AND TURNOVER RATES.
Alaska Univ., Fairbanks. Inst. of Marine Science.
D. G. Shaw, and D. J. McIntosh.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 31, No. 6, p 775-788, December 1990. 4 fig, 3 tab, 28 ref. NSF Grant OCE-8613612.

Descriptors: *Acetates, *Anoxic conditions, *Estuarine environment, *Marine sediments, *Mineralization, *Sediment chemistry, Alaska, Biochemistry, Chemical reduction, Interstitial water, Organic matter, Oxidation, Skan Bay, Sulfates.

While acetate is generally regarded as an important intermediate in the mineralization of organic matter in anoxic sediment systems, some quantitative studies in marine systems have measured acetate oxidation rates in excess of sulfate reduction rates where sulfate is known to be the principal electron acceptor. Skan Bay, Alaska, where such observations had been made previously, was revisited for a reexamination of acetate turnover. Measurements of acetate concentrations, production rate, oxidation rate, and sulfate reduction rate as well as bioenergetic considerations led to the conclusion that acetate oxidation rate in 15-18-cm deep sediment is 1.1-1.5 microM/h. The possibility that previous measurements were high because of an acetate oxidation pathway outside of the citric acid cycle (suggested by recent laboratory studies) was excluded. It appears that the previous turnover measurements were high mainly because of high acetate concentrations. Procedures used for the isolation of porewater for acetate determination may influence results to an extent not previously recognized. (Author's abstract)
W91-07862

BENTHIC MICROALGAL BIOMASS IN SEDIMENTS OF ONSLOW BAY, NORTH CAROLINA.
North Carolina Univ. at Wilmington. Dept. of Biological Sciences.
L. B. Caloon, R. S. Redman, and C. R. Tronzo.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 31, No. 6, p 805-816, December 1990. 2 fig, 2 tab, 42 ref. UNC Sea Grant R/MG 84-07.

Descriptors: *Algae, *Benthic environment, *Continental shelf, *Marine sediments, *North Carolina, Adenosine triphosphate, Benthic flora, Chlorophyll a, Light penetration, Nutrients, Organic carbon, Phytoplankton, Pigments, Primary productivity, Sediments, Storms.

Sediment samples were collected at stations along cross-shelf transects in Onslow Bay, North Carolina, during two cruises in 1984 and 1985. Station depths ranged from 11 to 285 m. Sediment chlorophyll a concentrations ranged from 0.06 to 1.87 micrograms/g sediment (mean, 0.55). Areal sediment chlorophyll a exceeded water column chlorophyll a at 16 of 17 stations, especially inshore and mid-shelf stations. Sediment ATP concentrations ranged from 0 to 0.67 micrograms/g sediment (mean, 0.28). Values for both biomass indicators were lowest in the depth range including the shelf break (50-99 m). Organic carbon contents of the sediments were uniformly low across the shelf, averaging 0.159% by weight. Photography of the sediments revealed extensive patches of microalgae on the sediment surface. These data suggest that viable benthic microalgae occur across the North Carolina continental shelf. The distribution of benthic macroflora on the North Carolina shelf indicates that sufficient light and nutrients are available to support primary production out to the shelf break. Frequent storm-induced perturbations do not favor settling of phytoplankton, an alternative explanation for the presence of microalgal pigments in the sediments. Therefore, it is proposed that a distinct, productive benthic microflora exists across the North Carolina continental shelf. (Author's abstract)
W91-07863

LINKS BETWEEN PHYSICAL, CHEMICAL AND BIOLOGICAL PROCESSES IN BASHITA-MINATO, A MANGROVE SWAMP IN JAPAN.
Tokai Univ., Shizouka (Japan). Faculty of Marine Science and Technology.
Y. Mazda, Y. Sato, S. Sawamoto, H. Yokochi, and E. Wolanski.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 31, No. 6, p 817-833, December 1990. 14 fig, 12 ref, append. Ministry of Education, Science and Culture (Japan) Grant 62540307.

Descriptors: *Japan, *Mangrove swamps, *Reefs, *Swamps, *Tidal effects, *Water chemistry, *Water properties, *Wetlands, Algae, Anoxic conditions, Benthic flora, Chemical properties, Detritus, Diurnal variation, Erosion, Organic matter, Oxygen balance, Photosynthesis, Ponding, Rainfall, Respiration, Sand, Spring tides, Storms, Tides, Water temperature.

Field measurements were carried out in the summers of 1985-1988 in Bashita-minato, a mangrove swamp in Japan. This swamp is separated from a coral reef slightly offshore by a sill of coral sand. Because of storm-dominated formation and erosion of the sill, the water properties in the swamp vary widely with time. When water flows over the sill into the swamp from a nearby coral reef at flood tide, the oxygen cycle and the water properties in the swamp depend on both the semidiurnal tidal flows and the diurnal cycle of oxygen concentration in reef waters, which is caused by biological activities (photosynthesis and respiration in the shallow coral reef area). When the entrance is blocked by the sill, the swamp becomes ponded, and the water temperature increases rapidly (1 C/day), with a temperature maximum at a mid-water layer as in a solar pond. The bottom layer, rich in organic matter from decaying mangrove detritus, becomes anoxic within a day after the sill closure. Various chemicals are then released from the bottom mud, the irradiance extinction coefficient increasing by as much as 1 m/day. This in turn results in continuous degradation in photosynthetic activity of benthic algae and in water properties until the sill is breached again under spring high tides or intense rainfall. (Author's abstract)
W91-07864

LONGITUDINAL TRANSPORT IN A COASTAL LAGOON.
Harbor Branch Inst., Inc., Fort Pierce, FL.
N. P. Smith.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 31, No. 6, p 835-849, December 1990. 6 fig, 1 tab, 26 ref.

Descriptors: *Coastal lagoons, *Indian River Lagoon, *Model studies, *Tidal effects, *Tides, *Water currents, Atlantic Coast, Finite difference methods, Florida, Seasonal variation, Water level fluctuations, Wind.

A two-dimensional, finite difference numerical model was used to describe longitudinal transport through a transverse cross section into and out of the northern segment of Indian River Lagoon along the Atlantic coast of Florida. The model uses four layers to represent the Atlantic Intracoastal Waterway, and two layers in the shallow waters east and west of the waterway to quantify transport. Simulations during a 161-day period from late June through late November 1983 include a seasonal shift in the longitudinal component of the wind. Transport is in the same sense throughout the cross section 32% of the time. Relatively subtle lateral shear, however, has a profound effect on long-term net transport. For most of the study, cumulative net transport in the shallow areas on either side of the waterway follows the cumulative along-channel windstress, but it is directed upwind in the lower half of the Intracoastal Waterway. Four numerical experiments examine the relative importance of terms in the momentum equation and components of the database. Results suggest that time-varying baroclinic forcing is an important component of the pressure gradient. Simulations that ignore water level variations at the open end of the model differ substantially from those that incorporate water level fluctuations. (Author's abstract)
W91-07865

SIZE COMPOSITION AND ESTIMATED PHOSPHORUS REGENERATION RATES OF THE COPEPOD COMMUNITY ALONG AN ESTUARINE-OFFSHORE TRANSECT IN THE INLAND SEA OF JAPAN.
Hiroshima Univ. (Japan). Faculty of Applied Biological Science.
For primary bibliographic entry see Field 5C.
W91-07866

GEOCHEMICAL STUDIES ON THE COASTAL LAKES OF KAMIKOSHIKI ISLAND IN KAGOSHIMA PREFECTURE, JAPAN: I. A PRELIMINARY REPORT.
Tokyo Metropolitan Univ. (Japan). Dept. of Chemistry.
For primary bibliographic entry see Field 2H.
W91-07870

COMPARATIVE STUDIES OF ESTUARIES BORDERING THE YELLOW SEA (IN CHINESE).
East China Normal Univ., Shanghai.
H. T. Shen.
Oceanologia et Limnologia Sinica (Hai Yang Yu Hu Chao) HYHCAG, Vol. 21, No. 5, p 449-457, 1990, 7 fig, 1 tab, 10 ref. English summary.

Descriptors: *Estuaries, *Estuarine sediments, *Sediment sources, *Sedimentation, *Stream discharge, *Yellow Sea, Bohai Bay, Changjiang River, China, Huang He River, Korea, Tidal range.

There are distinct differences between the rivers entering the Yellow Sea from the east shore and those entering from the west. Rivers entering from the eastern, or Korean, shore have smaller discharges of water and smaller sediment loads than rivers entering from the western, or Chinese, shore. The Chinese rivers have smaller tidal ranges. Because of these factors, the estuaries on the west side have reached a much more advanced stage of evolution and have low filtering efficiencies. Chinese rivers make much greater contributions of sediment to the Yellow Sea than do the Korean rivers. However, the northward shifting of the Huang He (Yellow) River Estuary into the Bohai Sea, and the southward shifting of the Changjiang (Yangtze) River Estuary, have resulted in a net reduction of sediment input in the Yellow Sea. (Author's abstract)
W91-07986

SEMI-AUTOMATED COLORIMETRIC AND ENZYMATIC ASSAYS FOR AQUATIC ORGANISMS USING MICROPLATE READERS.
Institut Francais de Recherche pour l'Exploitation de la Mer, Nantes.
For primary bibliographic entry see Field 2K.
W91-08048

NOCTURNAL AND TIDAL VERTICAL MIGRATIONS OF 'BENTHIC' CRUSTACEANS IN AN ESTUARINE SYSTEM WITH DIURNAL TIDES.
Rutgers - The State Univ., Camden, NJ. Dept. of Biology.
D. E. Stearns, and M. R. Dardeau.
Northeast Gulf Science NGSCDE, Vol. 11, No. 2, p 93-104, December 31, 1990. 7 fig, 2 tab, 54 ref.

Descriptors: *Alabama, *Crustaceans, *Diurnal variation, *Estuarine environment, *Migration, *Tidal effects, *Zooplankton, Amphipods, Animal behavior, Benthic fauna, Distribution, Isopods,

Opossum-shrimp, Physiological ecology, Population density, Predation, Salinity, Sampling, Temporal distribution, Tides, Vertical distribution.

Two field studies involving periodic sampling of the surface waters of the upper reaches of the Fowl River estuary in southwestern Alabama were completed in order to describe temporal changes in the densities of selected species of crustaceans larger than 505 microns. Regardless of tidal phase, triplicate 5-min surface tows collected very few crustaceans during the day, while nighttime zooplankton samples showed much higher densities of amphipods Gammarus tigrinus, Corophium lacustre, Grandidierella bonnieroides, the isopod Munna reynoldsi, the cumacean Almyracuma proximoculi, and the mysids Taphromysis spp. These results strongly indicate nocturnal vertical migration by crustaceans that are traditionally considered benthic. In addition, these species showed significantly higher densities near the water surface during nocturnal flood tides than during nocturnal ebb tides, indicating tidal vertical migration. These crustaceans are reported to inhabit low-salinity areas, and a transect along the length of this estuary showed relatively higher densities of these crustaceans in the lower-salinity waters upstream than in the higher-salinity waters downstream. While the adaptive value of vertical migration of an otherwise benthic organism is not clear, the nocturnal and tidal timing of such a migration appears to provide these oligohaline-mesohaline crustaceans with a behavioral mechanism that generally retains them in the upper reaches of the estuary with minimal exposure to visual predation in the water column. (Author's abstract)
W91-08083

BIOSORPTION OF INORGANIC TIN AND METHYLTIN COMPOUNDS BY ESTUARINE MACROALGAE.
New Hampshire Univ., Durham. Dept. of Chemistry.
For primary bibliographic entry see Field 5B.
W91-08103

ISOTOPIC DISTRIBUTION OF CARBON FROM SEWAGE SLUDGE AND EUTROPHICATION IN THE SEDIMENTS AND FOOD WEB OF ESTUARINE ECOSYSTEMS.
Rhode Island Univ., Narragansett. Graduate School of Oceanography.
For primary bibliographic entry see Field 5B.
W91-08104

RARE EARTH ELEMENTS IN SEDIMENTS OFF SOUTHERN CALIFORNIA: A NEW ANTHROPOGENIC INDICATOR.
Massachusetts Inst. of Tech., Cambridge. Nuclear Reactor Lab.
For primary bibliographic entry see Field 5B.
W91-08105

TIDAL DISPERSAL OF SALT MARSH INSECT LARVAE WITHIN THE WESTERSCHELDE ESTUARY.
Delta Inst. for Hydrobiological Research, Yerseke (Netherlands).
M. A. Hemminga, J. van Soelen, and B. P. Koutstaal.
Holarctic Ecology HOECD2, Vol. 13, No. 4, p 308-315, December 1990. 4 fig, 3 tab, 25 ref.

Descriptors: *Coleoptera, *Estuaries, *Marine animals, *Salt marshes, *The Netherlands, *Tidal effects, Distribution patterns, Estuarine environment, Larvae.

In the Westerschelde estuary, (The Netherlands) salt marshes are present as isolated patches fringing the estuary. Tidal transport of stem-boring larvae of Agapanthia villosoviridescens (Coleoptera) from salt marshes of the upper reaches of the Westerschelde estuary to marshes of the lower reaches is an important process in the maintenance of genetic variability and persistence of local populations. The evidence for the origin of the larvae is based on comparisons of growth and development characteristics of larvae found in flood debris belts containing halophytic Aster stems which host the resident larval populations. These characteristics are different on the various salt marshes along the Westerschelde, probably as a result of estuarine salt gradients on the host plant. Additional evidence for the larval origin comes from the plant composition of the flood debris. The occurrence of upward tidal transport is dependent on tidal movements, flooding, wind direction and speed. The impact of the influx of immigrant larvae on the local population may be greater than their numbers would suggest, because the larvae are highly aggressive toward each other and the immigrants as a whole are larger-sized than the resident population. Considering the comparatively large area of salt marshes in the upper estuary, tidal dispersal of larvae probably will be dominated by transport in a seaward direction. So far, very little is known about the role of tidal currents with regard to the exchange between salt marsh populations. The present results suggest that tidal transport may not only be important for dispersal of aquatic organisms in an estuary, but also for organisms inhabiting the semi-terrestrial estuarine salt marshes. (Doyle-PTT)
W91-08109

METEOROLOGICAL CONDITIONS THAT KEPT LONG ISLAND AND NEW JERSEY BEACHES FREE OF FLOATABLES DURING THE SUMMER OF 1989.
State Univ. of New York at Stony Brook.
For primary bibliographic entry see Field 5B.
W91-08112

TOXIC IMPACT OF ALDRIN ON ACID AND ALKALINE PHOSPHATASE ACTIVITY OF PENAEID PRAWN, METAPENAEUS MONOCEROS: IN VITRO STUDY.
Sri Venkateswara Univ., Kavali (India). Div. of Toxicology.
For primary bibliographic entry see Field 5C.
W91-08168

METHANE FLUXES IN THE SOUTHERN NORTH SEA: THE ROLE OF EUROPEAN RIVERS.
State Univ. of New York at Stony Brook. Marine Sciences Research Center.
For primary bibliographic entry see Field 5B.
W91-08169

INFLUENCE OF LOCAL WIND FORCING ON THE LOW-FREQUENCY VARIATIONS OF CHLOROPHYLL A IN A SMALL MARINE BASIN.
Bedford Inst. of Oceanography, Dartmouth (Nova Scotia). Dept. of Fisheries and Oceans.
M. R. Mitchell.
Continental Shelf Research CSHRDZ, Vol. 11, No. 1, p 53-66, January 1991. 8 fig, 28 ref, append.

Descriptors: *Chlorophyll a, *Flushing, *Nova Scotia, *Phytoplankton, *Tidal basins, *Wind-driven currents, Canada, Marine algae, Nutrient transport, Primary productivity, Regression analysis, Variability.

An investigation was made on the influence of wind forcing on the low-frequency variations of chlorophyll a (Chl a) in Bedford Basin, a small and highly productive marine basin on the coast of Nova Scotia, Canada. Sampling was conducted during spring and summer of 1982. Time series of chlorophyll a was collected over a period of 5 months using a moored, in site fluorometer package. The vertical distribution of Chl a in the Basin was usually marked by a sharp gradient between 10 and 15 m, and Chl a was generally confined to a layer less than 10 m thick. The power spectrum of Chl a showed two significant non-tidal peaks, one centered at 10 days which contributed 34% of the total variance, and one centered at 2 days which represented 5% of the total variance. Regression analysis indicated that meteorological forcing terms accounted for significant amounts of the variance of Chl a at periods that match the two peaks. More than 50% of the variance at the 2 day period was accounted for with the cross-shore component of the wind stress, and cross-shore and alongshore components of wind stress accounted for about 40% of the 10 day period variance. Although wind events are known to be an important source of Chl a variations, this study indicated that the regular periodic wind forcing is also a major influence. (VerNooy-PTT)
W91-08170

OXYGEN CONDITIONS IN THE DEEP WATER OF KIEL BAY AND THE IMPACT OF INFLOWING SALT-RICH WATER FROM THE KATTEGAT.
Kiel Univ. (Germany, F.R.). Inst. fuer Meereskunde.
M. Weigelt.
Meeresforschung MEERDW, Vol. 33, No. 1, p 1-22, December 1990. 12 fig, 2 tab, 31 ref.

Descriptors: *Deep water, *Dissolved oxygen, *Estuaries, *Germany, *Kiel Bay, *Oxygen deficit, *Salinity currents, *Water quality, Anoxic conditions, Data interpretation, Hydrological data collections, Nutrients, Primary productivity, Seasonal variation, Water temperature.

The longest continuous series of hydrological data from Kiel Bay (Germany), compiled from 1957 through 1975, was recorded near Boknis Eck in the southwestern part of Kiel Bay. More data, including temperature, salinity and oxygen content, were provided from this station from 1979 to 1981 and from 1983 through 1985. In the deep water of Boknis Eck the oxygen conditions have deteriorated significantly since the 1950s. Comparing data from Boknis Eck and Lightship Fehmarnbelt reveals that each distinct influx of salt-rich deep water from the Kattegat into the Baltic Sea can be detected in the southwestern part of Kiel Bay a few weeks before it is observed in the Fehmarnbelt. Therefore, the frequency of deep water exchange seems to be about the same everywhere in the deeper parts of Kiel Bay. However, in summer, the oxygen content of the inflowing deep water is often very low when it reaches the northeastern part of Kiel Bay. For example, it was less than 40% saturated in July 1984. This seems to contribute considerably to the general deterioration of oxygen conditions in this region. For prediction of the oxygen availability in Kiel Bay during any given year, three preconditions should be known in addition to the nutrient supply and primary production. These include: the amount of water exchange and renewal during the previous winter(s); weather conditions during the summer; and quantities of nutrients, primary production, and consequently organic matter and biological oxygen demand in the regions from which the inflowing deep water originates. Comparison between the oxygen depletion events in 1967 and 1981 demonstrates that, at present, a shorter stagnation phase is sufficient to cause a greater catastrophe than during previous years. It is conceivable that the conditions in the Baltic are changing to those normal for the Black Sea, where the water below the halocline is permanently anoxic. (VerNooy-PTT)
W91-08180

SKELETAL DEFORMITIES AND TRACE METAL CONTENTS OF EUROPEAN SMELT, OSMERUS EPERLANUS, IN THE ELBE ESTUARY.
Kiel Univ. (Germany, F.R.). Inst. fuer Meereskunde.
For primary bibliographic entry see Field 5C.
W91-08181

LOCAL FISH KILL IN A POND AT THE GERMAN NORTH SEA COAST ASSOCIATED WITH A MASS DEVELOPMENT OF PRYMNESIUM SP.
Forschungs- und Technologiezentrum Westkuste, Buesum (Germany, F.R.).
For primary bibliographic entry see Field 5C.
W91-08182

DATA COLLECTION PROGRAM FOR PAMLICO RIVER ESTUARY MODEL CALIBRATION AND VALIDATION.
Geological Survey, Raleigh, NC. Water Resources Div.
For primary bibliographic entry see Field 7B.
W91-08186

3. WATER SUPPLY AUGMENTATION AND CONSERVATION

3A. Saline Water Conversion

DESALINATION AT THE CROSSROADS.
El-Saie (M.H.A.), Cairo (Egypt).
M. H. El-Saie.
Desalination DSLNAH, Vol. 78, No. 3, p 305-311, October 1990.

Descriptors: *Arid lands, *Desalination, *Future planning, *Research priorities, *Water supply development, *Water use, Desalination plants, Drought, Economic aspects, Energy, Human population, Institutional constraints, International agreements, Membrane processes, Multistage flash evaporation, Reverse osmosis, Reviews, Water quality, Water shortage.

The past, present, and future of desalination are reviewed. Two factors have affected the development of desalination in the past two decades: (1) the predictions related to set-up of new desalination units and their capacities; and (2) the readiness of companies and institutions to fund research and development in the field. Activity in the field decreases when demand for desalination plants decreases, leading to a slowdown in development of old and new methods. The following factors will affect the future of the desalination field: the number of productive units and the replacement of old or uneconomical units; scarcity of water; change of water quality; growth of population and per capita increase in water consumption; increase in drought in many countries; expansion in water reuse; availability of huge, cheap sources of energy in some areas; renewable energy; and the possibility of producing cheap and suitable heat energy by nuclear fusion. Desalination is therefore at a crossroads; either it will continue to be satisfied with prevailing methods, or a change in outlook is needed to encourage increased activity in all directions within the field. Consequently, it is proposed that a Supreme Council for Desalination for Saline Water be formed from countries producing distilled water and from research institutions in the field. (Doria-PTT)
W91-07382

COMPARISON BETWEEN SMALL CAPACITY MECHANICAL VAPOR COMPRESSION (MVC) AND REVERSE OSMOSIS (RO) DESALTING PLANTS.
Kuwait Univ., Safat.
M. A. Darwish, M. Abdel Jawad, and G. S. Aly.
Desalination DSLNAH, Vol. 78, No. 3, p 313-326, October 1990. 5 fig, 6 tab, 2 ref.

Descriptors: *Desalination, *Desalination apparatus, *Desalination plants, *Membrane processes, *Reverse osmosis, *Vapor compression distillation, Amortization, Capital costs, Comparison studies, Corrosion control, Cost analysis, Costs, Decision making, Economic aspects, Electric power costs, Energy, Feedwater treatment, Heat, Heat exchangers, Maintenance costs, Mechanical vapor compression, Operating costs, Performance evaluation, Pumps, Salts, Seawater.

Adoption of reverse osmosis (RO) or mechanical vapor compression (MVC) for small-capacity seawater desalination units in remote areas is a logical choice considering their comparative reliability and energy consumption. Cost comparisons should be based on equipment and consumed chemicals and energy. The following conclusions can be drawn from the characteristics of small-capacity RO and MVC plants of 100 cu m/d each: (1) electrical energy consumption by the MVC is twice that of the RO system and 3 times that of RO if electrical energy is used to provide auxiliary heat; (2) highly corrosion-resistant materials are required for components of the MVC system, increasing its cost to 3 times that of the RO system; (3) The MVC system requires 2 to 3 hours to restart after shutdown; (4) any brine droplets carried by the vapor to the compressor of the MVC system will deposit salt on the compressor blades, requiring frequent cleaning; (5) in the MVC system, the required heat-transfer surface area of the evaporator alone is about 250 sq m, with an additional 80 sq m required for the dual heat exchanger; and (6) the volume and weight required by the MVC system is about 75 cu m and 18 tons, while those required by RO are less than 10 cu m and 2 tons, respectively. (Doria-PTT)
W91-07383

PERFORMANCE OF AUSTENITIC STAINLESS STEELS IN MSF DESALINATION PLANT FLASH CHAMBERS IN THE ARABIAN GULF.
University of Petroleum and Minerals, Dhahran (Saudi Arabia). Research Inst.
H. Saricimen, M. Shamim, I. M. Allam, and M. Maslehuddin.
Desalination DSLNAH, Vol. 78, No. 3, p 327-341, October 1990. 10 fig, 1 tab, 15 ref. KFUPM/RI Project No. 25016.

Descriptors: *Corrosion, *Desalination apparatus, *Desalination plants, *Materials testing, *Multistage flash evaporation, *Persian Gulf, *Stainless steel, Arabian Gulf, Brines, Chlorides, Electron microscopy, Heat treatment, Microscopy, Stress.

The corrosion behavior of AISI type 304L (304L SS) and 316L (316L SS) stainless steels in a multistage flash (MSF) desalination plant located on the Arabian Gulf Coast was investigated. The 304L and 316L stainless steel liner plates in the flash chambers of the plant developed severe localized corrosion within 6 years of operation. Liner plate samples retrieved from the floors of flash chambers were studied using optical and scanning electron microscopes. The study showed that both 304L and 316L SS liner plates suffered severe intergranular pitting and crevice corrosion. Corrosion was more severe at welds and heat-affected zones (HAZs). The main causes of corrosion were identified as (1) exposure of the liner plates to stagnant high chloride brine, and (2) grain growth and probably sensitization of the stainless steels at HAZ during welding and stress-relieving heat treatment. (Author's abstract)
W91-07384

SYNTHESIS AND EVALUATION OF POLY (M-PHENYLENE ISOPHTHALAMIDE) AS A REVERSE OSMOSIS MEMBRANE.
Central Salt and Marine Chemicals Research Inst., Bhavnagar (India).
S. V. Joshi, and A. V. Rao.
Desalination DSLNAH, Vol. 78, No. 3, p 355-362, October 1990. 1 fig, 7 tab, 8 ref.

Descriptors: *Desalination, *Materials testing, *Membrane processes, *Membranes, *Polymers, *Reverse osmosis, Chemical reactions, Evaporation, Performance evaluation, Permeability, Salts, Solvents, Strength, Synthesis, Temperature, Viscosity.

Aromatic polyamides are finding use as alternate membrane materials for reverse osmosis applications. Poly(m-phenylene isophthalamide) is synthesized in the laboratory by low-temperature solution polycondensation of m-phenylene diamine and isophthaloyl chloride. A good reverse osmosis membrane must have good mechanical strength, high permeability to water, and low permeability to salt. Membrane formation is possible only with the polymer having an inherent viscosity of 0.7 or higher. Membrane strength was found to be basically dependent on its viscosity. Although the inherent viscosity of the optimized product is 1.22, it is slightly lower than that of Nomex (1.80); however, the cast membrane can be handled easily and has good mechanical strength. The transport characteristics of the membrane can be controlled by adjusting the solvent evaporation temperature and oven exposure time, which influence the rate of solvent evaporation in the cast membrane, leading to the formation of the pore structure. Higher oven temperature and longer exposure time result in a membrane of denser structure and reduced product flux and salt rejection. It is concluded that poly(m-phenylene isophthalamide) is a good membrane material with high pressure performance; its use in hollow fine fiber or ultrathin composite membrane is preferable to use as a flat membrane. (Doria-PTT)
W91-07385

ANALYSIS OF A FUEL-SOLAR ASSISTED CENTRAL DUAL PURPOSE PLANT.
King Abdulaziz Univ., Jeddah (Saudi Arabia). Dept. of Mechanical Engineering.
S. E. Aly.
Desalination DSLNAH, Vol. 78, No. 3, p 363-379, October 1990. 7 fig, 2 tab, 10 ref.

Descriptors: *Desalination, *Desalination plants, *Energy sources, *Fuel, *Solar energy, *Thermodynamics, Absorption, Condensers, Corrosion, Evaporation, Multistage flash distillation, Pumps, Steam, Steam turbines, Temperature.

A new arrangement for a central fuel-fired solar-assisted dual purpose plant (DPP) is presented and thermodynamically analyzed. The solar energy, collected at moderate temperatures, drives an open-cycle LiBr-H2O absorption machine with a low-pressure turbine replacing the condenser and the evaporator in such conventional heat pumps. In a DPP, this heat pump is connected upstream of the multistage flash (MSF) distiller where the low-pressure turbine receives the pass-out steam assigned to the MSF and the steam leaving the heat pump generator is fed to the MSF. Whenever it is applied to a central desert steam power plant (DSPP), the heat pump is introduced upstream of the steam condenser. The same basic steam cycle is used in analyzing the combined arrangement for both the DPP and DSPP with a reheat being used to reduce the low-pressure turbine corrosion problems. For a solar collecting temperature of 190 C for the DPP and 134 C for the DSPP, the power output increased by 56% and 53% at an extra firing of 10.5% and 21%, respectively. In the DPP, the combined arrangement can increase the water produced by fourfold at the design power output, or can increase the power output by 56% while maintaining the design water output. (Author's abstract)
W91-07386

ENGINEERING RELATIONS FOR ECONOMIC PRODUCTION FUNCTIONS OF SOLAR LOW-TEMPERATURE MULTI-EFFECT DESALINATION.
Patras Univ. (Greece). Dept. of Mechanical Engineering.
N. G. Zagouras, and E. T. Kantsos.
Desalination DSLNAH, Vol. 78, No. 3, p 381-387, October 1990. 4 fig, 1 tab, 5 ref.

Descriptors: *Desalination, *Economic aspects, *Model studies, *Multieffect distillation, *Solar distillation, *Solar energy, Cost analysis, Costs, Electric power costs, Engineering, Heat transfer, Mass balance, Mathematical models, Pricing, Temperature, Thermal energy.

Three simple and accurate engineering relations summarize the engineering results of a computational model related to the process of solar low-temperature multi-effect desalination. The relations providing the heat transfer surface, the installed electrical power, and the thermal energy are useful in facilitating the adjustment of the economic production function of the desalination process according to different price systems. Using these engineering relations is more convenient than using the process model (detailed engineering model with heat and materials balances incorporated) for the derivation of the economic production function. (Doria-PTT)
W91-07387

DETERMINATION OF A LIQUID STATE FROM THAT OF A LIQUID SOLUTION COUPLED TO IT BY A COMMON VAPOR PHASE.
Agricultural Research Service, Philadelphia, PA. Eastern Regional Research Center.
L. C. Dickey, and J. C. Craig.
Desalination DSLNAH, Vol. 78, No. 3, p 397-401, October 1990. 1 fig, 2 tab, 6 ref.

Descriptors: *Absorption, *Desalination, *Equilibrium, *Vapor pressure, *Vaporization, Cost analysis, Design criteria, Evaporation, Freezing, Sodium chloride, Thermodynamics, Water temperature.

Cost-effective absorber design is sufficiently complicated that published models and theories are of limited use in predicting performance. This is particularly true of designs where fibrous packing is used to increase the liquid/vapor contact surface. It was found that NaCl solutions of different concentration and temperature, separately flowing through a chamber with a common vapor phase, will be in a type of equilibrium despite the liquids not being in equilibrium with the vapor. The temperature of the liquid stream to which the vapor is flowing (the absorbing liquid) is that required to bring its calculated equilibrium vapor pressure to that of the calculated equilibrium vapor pressure of the evaporating liquid stream. It is suspected that this is a generally true phenomenon if the process is carried out close enough to conditions of actual equilibrium between the vapor and liquid phases. Although the generality of this phenomenon is not established, where it is valid it permits thermodynamic data, such as values of water activity, to be used rather than more complicated calculations based on mass transfer coefficients to design processes with coupled liquids. Moreover, the freezing process can be monitored by pooled absorbent temperature measurement. (Doria-PTT)
W91-07388

CALCIUM CARBONATE SCALE FORMATION AND PREVENTION IN A FLOW-THROUGH SYSTEM AT VARIOUS TEMPERATURES.
Patras Univ. (Greece). Dept. of Chemistry.
E. Dalas, and P. G. Koutsoukos.
Desalination DSLNAH, Vol. 78, No. 3, p 403-416, October 1990. 8 fig, 2 tab, 16 ref.

Descriptors: *Calcium carbonate, *Cooling water, *Desalination apparatus, *Pipelines, *Pumps, *Scaling, Calcite, Chelating agents, Diffusion, Kinetics, Supersaturation, Temperature, Thermodynamics.

The deposition of calcium carbonate in lines carrying hot water or in pumping systems is an undesirable process in most cases. The deposition of calcium carbonate was investigated in a closed, flow-through circuit. It was found, at plethostatic conditions, that in the temperature range between 50 and 80 C, vaterite is the initially forming phase, converting to the thermodynamically more stable calcite. The deposition took place within the stationary layers in which the supersaturation gradient was established. The deposition of vaterite was done by a surface diffusion controlled process, as suggested by the apparent activation energy of 36 kJ/mol found. The deposition rates as a function of the solution supersaturation suggested a polynuclear mechanism for the formation of vaterite on the heated specimens. Pretreatment of the specimens with concentrations of EHDP varying from 0.1 microM to 1 mM increased the induction times significantly and resulted in drastic reduction of the rates of deposition, which were more pronounced for the 316 stainless steel specimens. From the kinetics of precipitation data, the surface energy of the forming vaterite was estimated and was found to increase with temperature from 77 to 148 mJ/sq m. (Author's abstract)
W91-07389

FORMATION OF UF ROD-TYPE MEMBRANES.
Wroclaw Technical Univ. (Poland). Inst. of Environment Protection Engineering.
K. Majewska-Nowak, J. Wisniewski, and T. Winnicki.
Desalination DSLNAH, Vol. 78, No. 3, p 417-427, October 1990. 1 fig, 5 tab, 13 ref.

Descriptors: *Chemical engineering, *Desalination, *Membranes, *Reverse osmosis, *Ultrafiltration, *Wastewater treatment, Dyes, Polymers, Synthesis.

In engineering practice, it is conventional to form ultrafiltration and reverse osmosis tubular membranes on the surface of porous polymeric bars using the immersion method. Unfortunately, the method fails to provide membranes of the thickness desired. An apparatus was designed for mechanical casting of membranes on porous poly(methyl methacrylate) bar surfaces. Operating parameters of the apparatus were determined. The apparatus enables membrane thickness control by appropriate choice of the gap width and casting velocity. Recommended operating parameters are: gap width, 0.40 or 0.55 mm; casting rate, 50 or 100 mm/s. Polysulfone, poly(vinyl chloride) and polyacrylonitrile membranes retain organic dyes of molecular weights higher than 600 efficiently; retention coefficients have exceeded 90% in every instance. At a pressure of 0.15 mPa, volume flux of the permeate ranges from 0.4 cu m/sq m-d for poly(vinyl chloride) membrane to 2.3 cu m/sq m-d for polyacrylonitrile membrane. (Doria-PTT)
W91-07390

IMPACT OF REJECT WATER FROM THE DESALINATION PLANT ON GROUND WATER QUALITY.
Andhra Univ., Waltair (India). School of Chemistry.
For primary bibliographic entry see Field 5B.
W91-07391

EFFECTS OF CHLORINE DIOXIDE ON REVERSE OSMOSIS MEMBRANES.
Olin Corp., New Haven, CT.
W. R. Adams.
Desalination DSLNAH, Vol. 78, No. 3, p 439-453, October 1990. 9 fig, 7 ref.

Descriptors: *Antifoulants, *Chlorine dioxide, *Desalination, *Disinfection, *Membranes, *Reverse osmosis, Acidity, Fouling, Kinetics, Model studies, Oxidation, Water treatment.

Reverse osmosis (RO) membrane systems generally require treatment with a sanitizing agent to prevent microbiological growth. As many membrane materials are intolerant to chlorine, alternative sanitizers have to be considered. A study was conducted of the compatibility of several commercially available RO membranes to chlorine dioxide, an oxidizer that compares favorably to chlorine in terms of bactericidal efficacy. The compatibility of the membranes was determined as a function of chlorine dioxide concentration, solution pH, and exposure time. A kinetic model of the membrane degradation phenomena was derived, correlated to the data, and then used to predict useful membrane lifetime in feedwaters containing chlorine dioxide. Membranes were found to be intolerant to chlorine dioxide at high concentrations, where they degraded at rates comparable to those documented for chlorine. At concentrations of 1.0 ppm and below, however, the membranes had a greater tolerance to chlorine dioxide than to chlorine; at this concentration, chlorine dioxide is still effective as a sanitizing agent. Membranes were highly permeable to chlorine dioxide, so a low concentration in the feedwater will provide control both upstream and downstream. (Doria-PTT)
W91-07392

ELECTROHYDRODYNAMIC ENHANCEMENT OF EVAPORATION FROM NACL SOLUTIONS.
Macdonald Coll., Ste. Anne de Bellevue (Quebec). Dept. of Renewable Resources.
N. N. Barthakur.
Desalination DSLNAH, Vol. 78, No. 3, p 455-465, October 1990. 2 fig, 1 tab, 20 ref. Natural Sciences and Engineering Research Council of Canada and Brace Research Institute, Montreal, Quebec Grants 0GP0010245.

Descriptors: *Cooling, *Desalination, *Electric fields, *Evaporation, *Nucleation, *Saline water, Anions, Cations, Electrodes, Ions, Sodium chloride, Temperature.

Evaporation from and nucleation of saline solutions exposed to high fluxes of bipolar air ions produced by single corona electrodes were studied with a beta-ray gauge. NaCl solutions of various concentrations evaporated 3.5 to 3.9 times faster when exposed simultaneously to 0.94 trillion positive and 1.83 trillion negative ions/sq cm/s than freely evaporating control solutions. Evaporation enhancement occurred at a steady state temperature that was well below the corresponding wet bulb temperature. The nucleation sites in a solution were observed to be preferentially located below the overhead emitting electrodes; whereas the sites appeared to be spatially random for control solutions. The solutions exposed to the electrohydrodynamic (EHD) forces nucleated earlier than the control. Electric wind is primarily attributed to the evaporation rate enhancement and the accelerated nucleation at preferred sites in the solutions. An important field of application of this technique could be envisaged in desalination of seawater which is less concentrated than the saline solutions used in these experiments. If the evaporation rate can be further accelerated, the EHD forces could be used as a novel desalination technique that might prove to be energy efficient. The evaporated water could be condensed to the liquid state for human use. (Author's abstract)
W91-07393

3B. Water Yield Improvement

RESPONSE TO SALT AND WATERLOGGING STRESS OF TEN TAXA OF ACACIA SELECTED FROM NATURALLY SALINE AREAS OF WESTERN AUSTRALIA.
Western Australia Univ., Nedlands. Dept. of Botany.
For primary bibliographic entry see Field 3C.
W91-07306

EVALUATION OF THE RESPONSE OF A WATER TABLE TO A VARIABLE RECHARGE RATE.
K.N. Toossi Univ. of Technology, Tehran (Iran). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2F.
W91-07628

3C. Use Of Water Of Impaired Quality

RESPONSE TO SALT AND WATERLOGGING STRESS OF TEN TAXA OF ACACIA SELECTED FROM NATURALLY SALINE AREAS OF WESTERN AUSTRALIA.
Western Australia Univ., Nedlands. Dept. of Botany.
G. F. Craig, D. T. Bell, and C. A. Atkins.
Australian Journal of Botany AJBTAP, Vol. 38, No. 6, p 619-630, 1990. 5 fig, 3 tab, 19 ref.

Descriptors: *Acacia trees, *Australia, *Halophytes, *Saline soils, *Salt stress, *Salt tolerance, *Soil-water-plant relationships, *Waterlogging, Conductivity, Plant growth, Plant physiology, Saturated soils, Sensitivity analysis, Sodium, Survival.

Many Australian Acacia species appear to offer potential for planting on saline sites. Ten taxa of Acacia were selected from areas of moderate to high soil salinity (electrical conductivities of saturated soil paste extracts (EC) between 1000 mS/m and 4800 mS/m at 50 to 600 mm depth) and sodicity to test the tolerance of plants to increasing levels of salinity both with and without waterlogging. Nodulated plants, 3 months old, were grown in glasshouse experiments under one of four treatments: non-saline drained control (12 weeks); saline drained (12 weeks); non-saline waterlogged (5 weeks); and saline waterlogged (5 weeks). Acacia

cyclops, A. brumalis, A. redolens, and A. aff. lineolata had 100% survival after 12 weeks irrigation with saline solution (final EC = 9500 mS/m). Generally, the species tested were sensitive to waterlogging with A. patagiata, A. cyclops, and A. brumalis being the most sensitive, having 19 to 44% mortality with no salt in the solution. The combined treatment of salt and waterlogging greatly increased the mortality of plants, with four species having >70% mortality after 5 weeks treatment (EC = 3900 mS/m). A. aff. lineolata and A. mutabilis ssp stipulifera were highly tolerant of salt plus waterlogging, with 100% and 90% survival respectively. In salt plus waterlogged treatments, sodium ion concentration in phyllodes of all taxa exceeded that taken up by plants in freely drained salt treatments. Taxa with the slowest rates of growth tended to accumulate the highest concentrations of sodium ion in the uppermost phyllodes. Provenances of A. redolens and A. patagiata collected from sites of high soil salinity had less than half the sodium ion concentration in uppermost phyllodes at the termination of the salt treatment, compared with provenances of the same species collected from moderately saline sites, indicating that Acacia provenances collected from the most saline sites had greater potential to survive high levels of external salinity in the longer term than those from less saline sites. (Author's abstract)
W91-07306

CALIBRATION AND VALIDATION OF A MODIFIED STEADY-STATE MODEL OF CROP RESPONSE TO SALINE WATER IRRIGATION UNDER CONDITIONS OF TRANSIENT ROOT ZONE SALINITY.
Edinburgh School of Agriculture (Scotland). Dept. of Soil Science.
A. J. A. Vinten, H. Frenkel, J. Shalhevet, and D. A. Elston.
Journal of Contaminant Hydrology JCOHE6, Vol. 7, No. 1/2, p 123-144, January 1991. 7 fig, 5 tab, 18 ref.

Descriptors: *Crop yield, *Irrigation water, *Model studies, *Root zone, *Saline soils, *Saline water irrigation, Corn, Cotton, Crop production, Error analysis, Grain crops, Irrigation programs, Model testing, Parameter estimation, Tomatoes.

In many situations where annual crops are irrigated with saline water, root salinity does not reach a steady state. Use of a steady-state description of root zone salinity may then seriously overestimate the calculated leaching requirements of the crop. A steady-state semi-empirical model of crop response to irrigation with saline water has been calibrated using data from a number of field experiments. Predictions of yield deficit for cotton dry matter, seed cotton, forage corn, sweet corn, ryegrass, and tomatoes resulting from irrigation with saline water have been made for each of these experiments, using both the original model and a modified version which allows for the non-steady-state salinity conditions occurring in the experiments. Comparison with experimental data shows a clear superiority of the modified version in most cases studied. Where the original model is superior or equally good, it is likely that steady-state conditions are being approached. Where root zone salinity data were available and applicable, the modified model predicted root zone salinity much better. Approaches for distinguishing errors in calibration from intrinsic errors in the model assumptions include smoothing out the test data using a multiple regression equation which empirically describes observed yield in terms of measured parameters used in the model. By removing random error from yield data in this way the comparison between recalculated experimental yields and model predictions provides a more sensitive test of model validity. (Author's abstract)
W91-07586

SLUDGE MANAGEMENT IN SAN DIEGO.
Serpentix Conveyor Corp., Westminster, CO.
For primary bibliographic entry see Field 5E.
W91-07896

SALINIZATION HAZARD IN A POLDER SOIL OF BELGIUM.
Ghent Rijksuniversiteit (Belgium). Faculteit Landbouwwetenschappen.
For primary bibliographic entry see Field 2G.
W91-07954

3D. Conservation In Domestic and Municipal Use

DROUGHT MANAGEMENT AND ITS IMPACT ON PUBLIC WATER SYSTEMS.
Report on a Colloquium held September 5, 1985. Colloquium 1 of a Series. National Academy Press, Washington, DC. 1986. 127p.

Descriptors: *Drought, *Drought effects, *Planning, *Public policy, *Water management, *Water supply development, *Water use efficiency, California, Competing use, Los Angeles, Nonstructural alternatives, Risk assessment, Salt Lake City, Streamflow forecasting, Utah, Water conservation, Water supply, Water transfer.

A colloquium was held to discuss the subject of drought as it affects the management of public water systems. The first colloquium attempted to define drought and ranged from the need to know more of cause and effect and improved forecasting, to the legal procedures required to implement various management alternatives. Individuals noted for their expertise in areas of drought management were invited to present their views and insights on this subject at a meeting of 50 participants in Boulder, Colorado, on September 5, 1985. Drought, unlike other environmental disasters, does not have a sudden onslaught. Damage inflicted by drought usually occurs rather subtly over a span of months to years. Truly serious drought is usually a regionalized, as opposed to localized trauma, with the attendant need to broaden preplanning and mitigation efforts. Drought is considered to represent a period of time when streamflows, reservoir storage, and shallow groundwater levels are abnormally low as a result of climatically-induced moisture deficiency. There is need to direct both research and pragmatic mitigation efforts toward the neglected problems of water management during drought episodes. In the absence of adequate preparation, a drought may cause serious disruption for both consumptive and nonconsumptive water users. Topics covered during the colloquium include dimensions of drought management for public water supplies, the causes and occurrence of drought, acceptable risks for public systems subject to drought, drought management options, and legal and institutional aspects of drought management. Appendices to the text include the Emergency Water Conservation Plan of the City of Los Angeles and a summary of the Los Angeles Emergency Water Conservation Ordinance, and the Salt Lake County Water Conservancy District Rationing Plan. (See W91-07795 thru W91-07799) (Geiger-PTT)
W91-07794

DIMENSIONS OF DROUGHT MANAGEMENT FOR PUBLIC WATER SUPPLIES.
Colorado Univ. at Boulder. Inst. of Behavioral Genetics.
G. F. White.
IN: Drought Management and Its Impact on Public Water Systems. National Academy Press, Washington, DC. 1986. p 11-23. 2 tab, 31 ref.

Descriptors: *Drought, *Municipal water, *Nonstructural alternatives, *Water management, *Water supply development, *Water use efficiency, Irrigation, Management planning, Planning, Public policy, Water conservation, Water demand, Water supply.

The numerous dimensions of public water supply and drought are reviewed with respect to the broader aspects of time, place and quality. The provision of water as a public service competes with other public services for city funds. Drought is only one of the wide range of natural and technological hazards to which a public water supply is vulnerable. When compared to other hazards such as floods, hurricanes, earthquake and chemical spills, droughts occur with a lower frequency and have a longer onset time and duration. Droughts may be rated as less important than other concerns and may receive less attention and public funding. Drought has claimed national attention in three major periods in U. S. history: in the 1930's when the U.S. Geological Survey surveyed suffering communities, the 1950's to 1970's when the water conservation movement took hold, and the late 1980's when effects of pollution on the water supply were considered on a global scale. At least four spatial dimensions of the urban water supply situation interact to affect in quite different ways the vulnerability of cities to drought. These are population size, rates of growth or decline, groundwater availability, and agricultural use of water. The smaller municipalities and those with poor planning and meager surface water supplies have the higher probabilities of suffering shortage of water. Cities with access to good quality groundwater often find ways of improvising in times of shortage. Transfer of irrigation water from agricultural use to municipal use in time of drought may be practiced without severe effects upon agriculture. Institutional and administrative dimensions can be thought of as falling into four classes: organizational competence, legal and administrative capacity, technical skill in analysis, and basic data for analysis. The innovation and testing of new legal and administrative devices to permit municipalities to join in water management, to operate a market for water rights, and to share experience in planning and gaining public acceptance for water conservation measures deserve vigorous support beyond what is already under way. (See also W91-07794) (Geiger-PTT)
W91-07795

WHAT ARE ACCEPTABLE RISKS FOR PUBLIC SYSTEMS.
Los Angeles City Dept. of Water and Power, CA.
D. L. Georgeson.
IN: Drought Management and Its Impact on Public Water Systems. National Academy Press, Washington, DC. 1986. p 49-64. 1 fig, 3 tab, 1 ref.

Descriptors: *California, *Domestic water, *Drought, *Drought effects, *Management planning, *Municipal water, *Risk assessment, Competing use, Crop production, Decision making, Flood control, Future planning, Irrigation water, Urban areas, Water allocation, Water conservation, Water supply development.

During drought periods, various management strategies have been employed to allocate an inadequate water supply among competing users for that supply. The Bureau of Reclamations's Central Valley Project in California plans for agricultural drought management by making available Class 1 water in most years, and Class 2 water that is available on a less firm basis. In dry years farmers have the option of reducing their irrigated acreage of annual crops or increasing their production from alternative supplies such as individual wells. This system does not work well for urban users who cannot make an explicit annual decision on domestic water use needs. As a result of the Great California Drought of 1976-1977, many imaginative programs were implemented by federal, state, and local officials, as well as private companies, farmers, and individuals to cope with the water shortages. In Marin County water use was reduced by approximately 65% to only 45 gallons per person per day. After the drought, per capita water use returned to near predrought levels in most cities, even though conservation programs continued. Preliminary plans of the Imperial Irrigation District to conserve 100,000 acre feet per year involve lining canals and reducing water losses. The conserved water would be made available to Southern California which would reimburse Imperial $10 million annually to develop the conservation programs. Local governments should be involved in the planning stages of drought management to exercise police powers should they be needed for water rationing plans. Urban support is needed to increase the efficiency of agricultural water use. Public commitment to water conservation would likely erode quickly if financial penalties and other restrictions were perceived as not being enforced. If the public feels that water agen-

cies are managing water supplies responsibly and efficiently, they will be more likely to support proposed conservation measures in emergency situations. Groundwater storage basins can extend water supplies and increase flexibility during emergency situations. In California there are major legal and contractual problems associated with drought management planning. Since the consequences of urban water shortages are potentially very serious, the decision making should be made by the elected officials. (See also W91-07794) (Geiger-PTT)
W91-07797

DROUGHT MANAGEMENT OPTIONS.
Southern Illinois Univ., Carbondale. Dept. of Geography.
B. Dziegielewski.
IN: Drought Management and Its Impact on Public Water Systems. National Academy Press, Washington, DC. 1986. p 65-77. 1 tab, 9 ref.

Descriptors: *Drought, *Management planning, *Water conservation, *Water use efficiency, Drought effects, Future planning, Nonstructural alternatives, Public policy, Water demand, Water supply development, Water transfer.

Traditional approaches to water supply planning treat the question of droughts as a part of the capacity expansion problem. Typical capacity expansion projects involve the construction of new facilities for water storage, treatment, and transmission. Unconventional alternatives that have been considered in recent years include more efficient use of existing water supplies, use of groundwater aquifers for storage of excess supply of surface water, interbasin transfers, desalination of seawater or brackish groundwater, reclamation of wastewater and implementation of cloud-seeding projects. Demand management projects that can substantially reduce future water use may include: campaigns to educate the consumers on how to modify water use habits; promotion of a mandatory use of water-saving devices; promotion or mandatory requirements of low-water-use landscaping; adoption of efficient marginal cost pricing; and adoption of zoning and land use policies to control the number of water users served by the system. Drought emergency measures undertaken in response to anticipated shortages of water include: demand reduction measures, improvement in efficiency in water supply and distribution systems, and emergency water supplies. The information that would aid the most water managers in coping with water deficits during an actual drought is: the level of deficit most likely to result from an ongoing drought if no action is taken, the effectiveness of specific drought management measures, and the total cost of individual measures including the economic losses resulting from cutbacks in water delivery. The specific steps in the evaluation of demand reduction measures must include determination of: technical feasibility, social acceptability, implementation conditions to identify the agencies responsible for implementation and to define the temporal and sectoral coverage of each measure, effectiveness, utility's expenditures on implementing the measures, and the economic losses resulting from cutbacks in water delivery borne by the customers in various sectors of local economy. The need for expanding supply capacity of an existing system can be assessed by using the expected value of the cost of coping with drought emergencies during the planning period. A complete evaluation of short-term drought management measures will allow water utility managers to make more informed decisions during crisis situations. (See also W91-07794) (Geiger-PTT)
W91-07798

LEGAL AND INSTITUTIONAL ASPECTS OF DROUGHT MANAGEMENT.
Clyde and Pratt, Salt Lake City, UT.
E. W. Clyde.
IN: Drought Management and Its Impact on Public Water Systems. National Academy Press, Washington, DC. 1986. p 78-98.

Descriptors: *Drought, *Legal aspects, *Management planning, *Municipal water, *Water conservation, *Water use efficiency, Conjunctive use, Drought effects, Water demand, Water law, Water rights, Western United States.

Attempts to manage drought through legal and institutional means in the Western United States are reviewed. Streams in the West do not peak to coincide with the heaviest demand for water which is during the hot summer months. In the semiarid West, a city needs a substantial amount of surface storage to supply water for a two or three year carryover period. It also needs an aqueduct from the storage reservoir to the area of use with capacity to supply large quantities of water during periods of peak summer use. A water treatment facility that can meet peak use demands is also needed. In the event of scarcity of water the mayor of any town or the president of the board of trustees may limit the use of water for any purpose other than domestic use. Water districts have limited governmental powers. Public utilities have no governmental power and would rely on rights to ration through the public service commission. Water users may enter into a contractual agreement for water services which may include the right of the provider to ration or limit water use. Court rulings have upheld the rights of water districts to limit water use in the event of impending droughts. Pricing, water rationing, and water metering have been used to manage water use by customers. Cases are documented of water rights being sold or transferred to manage drought conditions. Water allocation processes usually allow adjustments for drought. Conjunctive uses of water will also help meet water needs during drought periods. Preferential use of water may be separated into three categories: high priority use supersedes all other rights and pays no compensation for water use, preferred use defined by statute and enforced by condemnation that must pay for taking another's water rights, and administrative discretion granted to public officials to choose among different uses in granting applications for permits to use water. In a case involving interstate transfer of water between New Mexico and Texas, the courts upheld New Mexico's right to limit transfer of water in cases of drought. (See also W91-07794) (Geiger-PTT)
W91-07799

3F. Conservation In Agriculture

MODELLING SOIL MOISTURE MOVEMENT FOLLOWING DRIP IRRIGATION OF SUGAR CANE.
Institute of Hydrology, Wallingford (England).
D. M. Cooper.
IN: ModelCARE 90: Calibration and Reliability in Groundwater Modelling. IAHS Publication No. 195. International Association of Hydrological Sciences, Washington, DC. 1990. p 385-396. 2 fig, 3 tab, 19 ref.

Descriptors: *Drip irrigation, *Model studies, *Sensitivity analysis, *Soil water, *Soil water potential, *Soil-water-plant relationships, *Unsaturated flow, Boundary conditions, Calibrations, Data interpretation, Field tests, Finite difference methods, Flow equations, Flow models, Mauritius, Root zone, Spatial distribution, Sugarcane, Tensiometers, Uncertainty.

Field measurements of soil water potentials were used in the assessment of a finite difference model of water movement. Measurements of soil moisture potential were taken from an intensively monitored grid of tensiometers located beneath a drip irrigated sugar cane crop at three replicate sites in Mauritius. Modelling drip irrigation is a special case of modeling soil moisture movement, with a point or line source. The boundary conditions for the problem were a no-flow boundary or steady drainage below the root zone, and no flow across a notional boundary at infinite horizontal distance from the dripline. A two-dimensional model was used to represent soil water movement along the plane of tensiometer locations. A discretized version of Richards equation was solved within the model region using a finite difference scheme with rectangular node-centered elements. The results of the investigation revealed that it was possible to calibrate soil moisture models using sequential gridded data and a finite difference model. However, measured values of moisture potential were barely sufficient to provide starting values for the analysis, but it was not possible to use a finer grid of tensiometers without causing excessive disturbance to the soil. This limited the model calibration, although the effect of incorrect initial conditions would disappear with time. The key source of uncertainty in the study was thought to be associated with spatial distribution of root uptake. (See also W91-07253) (Korn-PTT)
W91-07291

SOIL DENITRIFICATION AND NITRIFICATION POTENTIALS DURING THE GROWING SEASON RELATIVE TO TILLAGE.
Agricultural Research Service, Beckley, WV. Appalachian Soil and Water Conservation Research Lab.
T. E. Staley, W. H. Caskey, and D. G. Boyer.
Soil Science Society of America Journal SSSJD4, Vol. 54, No. 6, p 1602-1608, November/December 1990. 3 fig, 2 tab, 26 ref.

Descriptors: *Denitrification, *Nitrification, *Plant growth, *Crop production, *Soil chemistry, *Soil-water-plant relationships, *Tillage, Microorganisms, Nitrogen, Nutrient concentrations, Plant physiology, Seasonal variation, Soil management, Spatial distribution, Temporal distribution.

Soil management practices, through the alteration of various biological processes, can have a profound effect on nutrient availability to crops. During the growing season, the effect of no-tillage (NT) or conventional tillage (CT), location (between or within row), and N rate (0 or 56 kg N/ha) on soil potential denitrification activity (PDA) and potential nitrification activity (PNA) was investigated in a Gilpin silt loam (fine-loamy, mixed, mesic Typic Hapladults), planted with maize (Zea mays). For both PDA and PNA, most of the activity was concentrated in the soil surface (0 to 3.8 cm layer), especially under NT, and decreased to barely detectable levels in the deepest (15 to 30 cm) layer examined. Significant main effects were found for tillage, season, location for PDA in the soil surface layer. Tillage interacted only with season, resulting in an increase in PDA under NT, and a lack of response under CT, during the growing season in both the soil surface and the 3.8 to 7.6 cm layers. For PNA in the soil surface layer, significant main effects were found for all treatments. Only location interacted with tillage, resulting in a 50% increase in PNA from within rows to between rows under NT, and a lack of response under CT. In the 3.8 cm to 7.6 layer, the lowest order interaction was significant. In the 7.6 to 15 cm layer, PNA increased more rapidly under CT than NT during the growing season. These results demonstrate the importance of considering spatial distribution and time when these microbial activities are examined in tillage studies, and suggest the nitrogen losses under NT should exceed those under CT. (Author's abstract)
W91-07346

SPATIAL VARIATION IN DENITRIFICATION: DEPENDENCY OF ACTIVITY CENTERS ON THE SOIL ENVIRONMENT.
Copenhagen Univ. (Denmark). Inst. of Population Biology.
S. Christensen, S. Simkins, and J. M. Tiedje.
Soil Science Society of America Journal SSSJD4, Vol. 54, No. 6, p 1608-1613, November/December 1990. 4 fig, 4 tab, 20 ref. NSF Grant BSR-83-18387.

Descriptors: *Acidic soils, *Denitrification, *Hydrogen ion concentration, *Soil chemistry, *Soil water, *Spatial variation, Field tests, Flooding, Frequency distribution, Seasonal variation.

The spatial variation in field denitrification rates was studied in an acid soil where the sole denitrification end product was N20. The rate of N2O accumulation was measured under soil cover at 30 fixed sampling locations arranged in a grid. Water and nitrate were added prior to all measurements

to provide soil water contents at or above field capacity and excess nitrate for denitrification. No significant differences in N2O production rates were observed in samples incubated with or without C2H2, indicating that nitrificiation is not a significant source of N2O in this soil. Denitrification was found to occur in 'hot spots' in moist soil and throughout the soil volume if the soil was flooded. Denitrification rates followed a skewed frequency distribution when soil water content was at field capacity; most locations had low activity; and a few locations exhibited high activity. The frequency distribution of denitrification rates was less skewed in samples after flooding, following large additions of glucose, or when the vegetation underwent decay in the fall. The intensity of denitrification was much higher after flooding than following glucose addition. A few sample locations occasionally showed outstandingly high denitrification rates when at field capacity, as well as flooded. The activity in these hot spots approximated the potential denitrification activity of that soil. (Author's abstract)
W91-07347

TEMPORAL PATTERNS OF SOIL DENITRIFICATION: THEIR STABILITY AND CAUSES.
Copenhagen Univ. (Denmark). Inst. of Population Biology.
S. Christensen, S. Simkins, and J. M. Tiedje.
Soil Science Society of America Journal SSSJD4, Vol. 54, No. 6, p 1614-1618, November/December 1990. 4 fig, 3 tab, 11 ref. NSF Grant BSR-83-18387.

Descriptors: *Denitrification, *Soil chemistry, *Soil water, *Temporal variation, Aerobic conditions, Anaerobic conditions, Glucose, Infiltration capacity, Nitrates, Nitrous oxide, Nutrient concentrations, Particulate matter, Slurries, Soil organic matter.

The temporal stability of denitrification activity was assessed by monitoring nitrous oxide production in 30 rings installed in an acid sandy loam soil in which nitrous oxide was the only gaseous product of denitrification. When soil water was kept at field capacity or above, in the absence of nitrate limitation, some locations showed high denitrification compared with the average activity. These high activity locations persisted for up to several weeks. The ranking of locations with respect to denitrification rates was more stable over time than would have been expected due to chance alone. Additions of particulate organic matter (POM) that stimulated denitrification within 2 hours in anaerobic soil slurries did not increase denitrification until 5 days after addition to soil cores. The increase in denitrification was preceded by an increase in respiration. The denitrification activity within the 'hot spots' created by addition of POM was not limited by diffusion of nitrate in the soil. The addition of glucose 9 days before the injection of POM into field rings reduced the lag time preceding increased denitrification. Therefore, the delayed response of denitrification following POM addition in aerobic soil probably reflects the time required to establish an anaerobic soil volume. (Author's abstract)
W91-07348

MODELING WATER BALANCE AND GRASS PRODUCTION.
Agriculture Canada, Ottawa (Ontario). Land Resource Research Centre.
R. de Jong, and P. Kabat.
Soil Science Society of America Journal SSSJD4, Vol. 54, No. 6, p 1725-1732, November/December 1990. 7 fig, 1 tab, 35 ref.

Descriptors: *Crop yield, *Grasslands, *Irrigation design, *Mathematical models, *Model studies, *Netherlands, *Soil-water-plant relationships, *Water balance, Calibrations, Climates, Irrigation, Leaf area index, Plant growth, Prediction, Seasonal variation, Soil water, Transpiration, Water stress.

The soil water-crop production model SWACROP was adapted and tested for grassland production under the weather conditions and management practices encountered on sandy soils in the Netherlands. The model, which required soil physical and crop properties as input, was driven by meteorological data. The main output of the soil water balance module (SWATRE) included actual transpiration and the distribution of soil water contents and pressure heads over depth and time. The crop production module (CROPR) calculated dry-matter yields of roots, stubble, and harvestable sward. The CROPR module was also used to calculate leaf-area index and soil cover, which formed feedback loops with the soil water balance. After initial calibration, 85% of the predicted soil water contents in the root zone fell within 10% of the measured data. Seasonal accumulated grass yield, predicted by the model under non-stressed conditions, was within 10% of the measured yield, but yields during dry periods were overestimated. Discrepancies between measured and predicted yields under irrigated and nonirrigated conditions were attributed to the model's inability to stimulate growth and death rates of individual plant organs. (Author's abstract)
W91-07353

TILLAGE AND CROP ROTATION EFFECT ON CHARACTERISTICS OF A SANDY SURFACE SOIL.
Southern Piedmont Conservation Research Center, Watkinsville, GA.
For primary bibliographic entry see Field 2G.
W91-07356

EMERGING PRIORITIES FOR AGRICULTURAL RESEARCH IN THE 1990S.
For primary bibliographic entry see Field 5G.
W91-07443

EFFECT OF NPKS FERTILIZATION ON THE NATURAL GRASSLANDS OF MAGALLANES AND ITS MODIFICATION DUE TO SOIL AND CLIMATIC FACTORS (RESPUESTA DE LAS PRADERAS DE MAGALLANES A LA FERTILIZACION NPKS Y SU MODIFICACION POR FACTORES DE SUELO Y CLIMA).
Estacion Experimental Kampenaike, Punta Arenas (Chile).
J. Ruz, and C. Covacevich.
Agricultura Tecnica AGTCA9, Vol. 50, No. 1, p 33-42, March 1990. 2 fig, 7 tab, 12 ref. English summary.

Descriptors: *Climatic effects, *Fertilization, *Grasslands, *Semiarid lands, *Soil-water-plant relationships, *Water use efficiency, Agricultural practices, Chile, Nutrients, Plant growth, Root development, Soil water.

The application of fertilizer increased the production of forage in unirrigated grasslands, according to studies in the natural grasslands of the Kampenaike region of the Chilean Patagonian Range. A 70% increase in the amount of forage produced per millimeter of rain was observed. It is important to consider that in a semiarid region fertilized plants probably attain greater root growth and this improves their ability to extract soil moisture. Plant growth was measured in both fertilized and unfertilized pastures from 1977 to 1979. The growing period in the region starts in September and goes until December, and the calculated water use during this period included both rain water and the ground water available for plant growth. All the rain water was assumed to be available and losses due to run-off and deep percolation were not considered. The efficiency of water use for unfertilized pastures was 10.4 in 1977, 6.6 in 1978 and 10.8 kg/ha/mm in 1979, and for fertilized pastures 17.1 in 1977, 10.5 in 1978 and 21.9 in 1979. The annual rainfall in the region was 292.7 mm in 1977, 315 mm in 1978 and 269 mm in 1979. Rainfall during the growing season was 78 mm in 1977, 71.5 mm in 1978 and 70.5 mm in 1979, and water use was 90 mm in 1977, 100.5 mm in 1978 and 84.5 mm in 1979. (King-PTT)
W91-07520

ECOLOGICAL BACKGROUND, DETERIORATION AND RECLAMATION OF DESERT DUNE SAND.
Ben-Gurion Univ. of the Negev, Beersheba (Israel). Dept. of Geography.
For primary bibliographic entry see Field 2G.
W91-07548

TRADITIONAL MONTANE IRRIGATION SYSTEMS IN MODERN EUROPE: AN EXAMPLE FROM VALAIS, SWITZERLAND.
Downing Coll., Cambridge (England).
A. T. Grove, and J. M. Grove.
Agriculture, Ecosystems and Environment AEENDO, Vol. 33, No. 2, p 181-186, December 1990. 1 fig, 7 ref.

Descriptors: *Europe, *History, *Irrigation canals, *Irrigation programs, *Rural areas, *Switzerland, *Water distribution, *Water management, *Water use, Annual precipitation, Cropland, Meadows, Reservoirs, Social impact, Societies.

The Valais of southwest Switzerland is the driest part of the country, with mean annual precipitation totals of about 600 mm on the floor of the lower Rhone valley, mainly during winter with high insolation and evaporation in the summer. The Bisse de Bitaille irrigation channel dates back to the early 13th century. The existing regulations on the use and distribution of the water and the upkeep of the Bisse date back to the 16th century. Several small reservoirs were built in the early 19th century to store excess water and avoid need for Sunday watering. In many mountainous regions around the Mediterranean, ancient irrigation systems lead water from high-elevation sources to meadows and cropland. Some of these systems have remained in use over a period of 600 years or more. They originated in rural societies which continued to operate them. They were always vulnerable to natural hazards. Presently, they are under threat from social changes and also from large-scale engineering works. Many of the bisse systems are still highly valued and in operation and although modernized, they remain under the control of communes. (Medina-PTT)
W91-07549

LARGE, RETRACTABLE, LOW COST AND RELOCATABLE RAIN OUT SHELTER DESIGN.
Queensland Dept. of Primary Industries, Kingaroy (Australia). J. Bjelke Petersen Research Station.
For primary bibliographic entry see Field 2I.
W91-07566

GRAIN AND FORAGE YIELD AND STOVER QUALITY OF SORGHUM AND MILLET IN LOW RAINFALL ENVIRONMENTS.
INTSORMIL, Gaborone (Botswana).
For primary bibliographic entry see Field 2I.
W91-07567

ROOT RESPONSE TO WATER STRESS IN RAINFED LOWLAND RICE.
International Rice Research Inst., Los Banos, Laguna (Philippines). Dept. of Agronomy.
For primary bibliographic entry see Field 2I.
W91-07568

EFFECT OF MIXED ROW CROPPING OF EARLY AND LATE MATURING RICE VARIETIES ON CROP PRODUCTIVITY UNDER INTERMEDIATE DEEPWATER CONDITIONS.
Central Rice Research Inst., Cuttack (India). Agronomy Div.
For primary bibliographic entry see Field 2I.
W91-07570

USING A PROGRAMMABLE CALCULATOR FOR DETERMINING POTENTIAL EVAPORATION RATES.
Fort Lauderdale Research and Education Center, FL.
For primary bibliographic entry see Field 2D.
W91-07579

CALIBRATION AND VALIDATION OF A MODIFIED STEADY-STATE MODEL OF CROP RESPONSE TO SALINE WATER IRRIGATION UNDER CONDITIONS OF TRANSIENT ROOT ZONE SALINITY.
Edinburgh School of Agriculture (Scotland). Dept. of Soil Science.
For primary bibliographic entry see Field 3C.
W91-07586

MODIFIED METHOD FOR DROUGHT IDENTIFICATION.
Indian Inst. of Tech., Madras. Dept. of Civil Engineering.
S. Mohan, and N. C. V. Rangacharya.
Hydrological Sciences Journal HSJODN, Vol. 36, No. 1, p 11-21, February 1991. 3 fig, 5 tab, 7 ref.

Descriptors: *Agriculture, *Drought, *Irrigation, *Model studies, *Rainfall-runoff relationships, *Water resources management, Areal precipitation, Catchment areas, Flow models, India, Parametric hydrology, Rainfall, Streamflow data.

Water management under drought conditions is a challenging task to irrigation and agricultural engineers. The parameters of interest in identifying drought include onset, termination, and severity. A methodology has been developed to identify those parameters from the available historic data on streamflow and rainfall having seasonal pattern. The procedure proposed involves determining the mean flow carry-over from month to month for the full period of record, calculation of the mean monthly and annual deficits, calculation of the mean monthly and annual flows, and a comparison of the sum of negative differences from the point in time at which the test begins with a sliding scale of 12 values calculated by linear interpolation between the maximum of the mean monthly flows and deficits. The differences for succeeding months of record are inspected until a month with a negative difference is found, representing the possibility of the start of a drought. The absolute value of the negative difference is compared with the first value of the sliding scale, and if equalled, a drought is deemed to have started. Simultaneous with this sequential testing, the algebraic sum of all differences is found from the first month of test, and if at any time during the eleven tests the sum became positive, the potential drought is deemed to have ended. This modified methodology was applied to the streamflow series of the Bhadra river and the mean areal rainfall series for the catchment of the Bhadra reservoir in Karnataka State, India. The droughts identified by the proposed methodology are concurrent with the historically realized droughts, thus providing the viability and applicability of the methodology in the identification of drought conditions. (Fish-PTT)
W91-07624

STABILIZING HILLSIDE FARMING SYSTEMS IN THE SIERRA OF THE DOMINICAN REPUBLIC.
California Univ., Albany. Div. of Biological Control.
For primary bibliographic entry see Field 4D.
W91-07749

TERRACING RE-EXAMINED IN THE LIGHT OF RECENT FINDINGS IN NEPAL AND INDONESIA.
Gibsons, British Columbia, Canada.
For primary bibliographic entry see Field 4D.
W91-07750

DRYLAND AGRICULTURE: STRATEGIES FOR SUSTAINABILITY.
Advances in Soil Science, Volume 13. Springer-Verlag New York, Inc., New York. 1990. 373p. Edited by R. P. Singh, J. F. Parr and B. A. Stewart.

Descriptors: *Agricultural practices, *Agricultural water, *Agriculture, *Arid climates, *Arid lands, *Dry farming, *Environmental impact, *Irrigation, *Resources management, *Semiarid climates, *Semiarid lands, *Soil conservation, *Water conservation, Economic aspects, Erosion, Erosion control, Research priorities, Species diversity, Tillage.

The continuing growth in world population demands the development of long-term sustainable dryland farming systems. Irrigation has played a particularly important role in the rapid increase in food production between 1950 and 1985. Strategies are presented for productive, profitable, and environmentally sound farming systems for both the dryland/rainfed areas of the United States and the arid and semiarid regions of developing countries. Aspects of dryland farming covered include soil and water conservation, erosion, tillage, residue management, integration of crops and livestock, biological diversity, and economics. Expansion of agriculture in fragile regions presents a major challenge because soil degradation can occur quickly. (See W91-07753 thru W91-07766) (Brunone-PTT)
W91-07752

IMPROVING THE SUSTAINABILITY OF DRYLAND FARMING SYSTEMS: A GLOBAL PERSPECTIVE.
Agricultural Research Service, Beltsville, MD.
J. F. Parr, B. A. Stewart, S. B. Hornick, and R. P. Singh.
IN: Dryland Agriculture: Strategies for Sustainability. Advances in Soil Science, Volume 13. Springer-Verlag New York, Inc., New York. 1990. p 1-8. 3 fig, 16 ref.

Descriptors: *Africa, *Agricultural practices, *Agriculture, *Arid climates, *Asia, *Dry farming, *Middle East, *Semiarid climates, Conservation tillage, Crop yield, Erosion control, Nutrient concentrations, Nutrient transport, Population density, Resources management, Runoff, Soil erosion, Soil properties, Subhumid climates.

Arid and semiarid regions comprise almost 40% of the world's land and are inhabited by some 700 million people. Low rainfall areas constitute from 75 to 100% of the land area in more than 20 countries in the Near East, Africa, and Asia. Crop yields in these area are extremely low compared with those of the humid and subhumid regions. Much of the food grain production decline results from the steady and continuing degradation of agricultural lands from soil erosion and nutrient depletion and the subsequent loss of soil productivity. Soils in these dryland areas are often coarse-textured, sandy, and inherently low in fertility, organic matter, and water-holding capacity and easily susceptible to wind and water erosion. The ultimate goal of sustainable agriculture is to develop farming systems that are productive and profitable, conserve the natural resource base, protect the environment, and enhance health and safety. Cultural and management practices such as crop rotations, recycling of animal manures, and conservation tillage to control soil erosion and nutrient losses and to maintain or enhance soil productivity are needed to achieve acceptale levels of sustainable crop yields and livestock production. An important relationship for most agricultural soils is that degradative processes such as soil erosion, nutrient runoff losses, and organic matter depletion are going on simultaneously with the beneficial effects of conservation practices. Climate and soil are the two most critical factors that will determine the ultimate sustainability of agricultural systems. The potential for erosion by water and, particularly, wind also tends to increase with increasing temperatures. The key to improving the sustainability of rainfed/dryland farming systems is to stop any further deterioration of the natural resource base. (See also W91-07752) (Brunone-PTT)
W91-07753

AGROCLIMATOLOGY OF SEMIARID LANDS.
National Soil Tilth Lab., Ames, IA.
J. L. Hatfield.
IN: Dryland Agriculture: Strategies for Sustainability. Advances in Soil Science, Volume 13. Springer-Verlag New York, Inc., New York. 1990. p 9-26. 8 fig, 2 tab, 40 ref.

Descriptors: *Agricultural practices, *Agriculture, *Climatology, *Rainfall, *Semiarid lands, Climates, Evaporation, Evapotranspiration, Mathematical models, Model studies, Precipitation, Seasonal distribution, Seasonal variation, Soil water, Solar radiation.

Rainfall, both in amount and distribution, often means the difference between adequate or scarce food supplies in subsistence agriculture. No one particular rainfall distribution pattern is associated with dryland or semiarid regions. Four types of rainfall patterns common in dryland areas are winter rainfall, summer rainfall, continental rainfall, and multimodal rainfall. Solar radiation for the dryland region is not very well-defined, primarily because of the lack of measurement sites. The seasonal and diurnal variations of temperature must be considered in understanding of an area's agroclimate. Measurements and maps of the atmospheric water content are of value for evapotranspiration, insect and disease models. General patterns of wind flow are dictated by the general circulation patterns and prevailing storm tracks. The water balance of an area is often a major factor in agricultural production in the semiarid regions, and agroclimatic indices are based on this precipitation-evaporation balance. Common models used to describe water loss include those of Thornthwaite, Blaney-Criddle, Jensen-Haise, Priestly-Taylor, Penman-Monteith, and the evaporation pan model. Climatic indices may range from the simple precipitation-potential evaporation ratios to more complicated soil-plant-atmosphere models. Climatic analysis for the semiarid regions requires integration of climatic, soils, and crop information. Interfacing the climatic probabilities of a number of parameters, such as rainfall, temperature, and evaporation, with crop growth models will provide a more complete description of the total agricultural system. (See also W91-07752) (Brunone-PTT)
W91-07754

CONSERVATION TILLAGE SYSTEMS.
Agricultural Research Service, Bushland, TX. Conservation and Production Research Lab.
P. W. Unger.
IN: Dryland Agriculture: Strategies for Sustainability. Advances in Soil Science, Volume 13. Springer-Verlag New York, Inc., New York. 1990. p 27-68. 19 tab, 149 ref.

Descriptors: *Agricultural practices, *Agriculture, *Conservation tillage, *Erosion control, *Soil moisture, *Tillage, *Water conservation, Dry farming, Evaporation, Organic matter, Plant growth, Rainfall infiltration, Soil aggregates, Soil physical properties, Soil water, Weed control.

Conservation tillage is an umbrella term covering a wide range of tillage practices that provide soil and water conservation benefits. The equipment requirements for conservation tillage vary, depending on which type of system is used. Weeds can be controlled by cultural methods or with herbicides, either singly or in various combinations, to prevent weed seed germination or seedling establishment. Yields of dryland crops are dependent on the amount of water available for use by the crop. Surface residues, as with conservation tillage systems, reduce runoff and increase infiltration by dissipating the energy of falling raindrops, thereby reducing soil aggregate dispersion that results in surface sealing, and retarding the flow rate of water across the surface. In many dryland regions, as in the US Great Plains, about 60% of the 500 mm of average annual precipitation may be lost directly from the soil by evaporation. Potential methods for decreasing evaporation include decreasing the turbulent transfer of water vapor to the atmosphere, decreasing capillary continuity, and decreasing capillary flow and water-holding capacity of surface soil layers. Many soils in dryland regions are highly susceptible to water erosion because of low crop yields, low soil organic matter content, high-intensity rainstorms, and poor management. To control water erosion, crop production operations such as tillage and seeding should decrease the impact of raindrops on the soil, maintain favorable water infiltration, decrease runoff velocity, and decrease soil detachability. Benefits from use of conservation tillage systems

include less air and water pollution, and decreased labor, energy and equipment requirements. (See also W91-07752) (Brunone-PTT)
W91-07755

TILLAGE AND RESIDUE MANAGEMENT EFFECTS ON SOIL ORGANIC MATTER DYNAMICS IN SEMIARID REGIONS.
Agricultural Research Service, Pullman, WA.
J. L. Smith, and L. F. Elliott.
IN: Dryland Agriculture: Strategies for Sustainability. Advances in Soil Science, Volume 13. Springer-Verlag New York, Inc., New York. 1990. p 69-88. 1 fig, 2 tab, 49 ref.

Descriptors: *Agricultural practices, *Organic matter, *Residue management, *Semiarid climates, *Soil moisture retention, *Tillage, *Water conservation, Agriculture, Arid lands, Dry farming, Humid climates, Infiltration rate, Irrigation, Nutrient concentrations, Soil crusts, Soil erosion, Soil water.

The organic matter content of agricultural soils is highly correlated with their potential productivity, tilth, and fertility. Dryland farming depends on yearly rainfall and timing, in contrast to irrigated arid lands and humid regions with adequate moisture for crop production. Soil organic matter (SOM) levels in semiarid regions are declining mainly because of intensive tillage practices which stimulate the microbiological decomposition of crop residues and residual SOM. Loss of SOM results in poorer soil structure, reduced infiltration rates, increased crusting, decreased water-holding capacity, increased resistance to root penetration, decreased nutrient availability, and accelerated soil erosion by both wind and water. Reduced tillage systems that will maintain and improve soil productivity can be adapted to the semiarid regions. (See also W91-07752) (Brunone-PTT)
W91-07756

TILLAGE SYSTEMS AND EQUIPMENT FOR DRYLAND FARMING.
Agricultural Research Service, Bushland, TX. Conservation and Production Research Lab.
O. R. Jones, R. R. Allen, and P. W. Unger.
IN: Dryland Agriculture: Strategies for Sustainability. Advances in Soil Science, Volume 13. Springer-Verlag New York, Inc., New York. 1990. p 89-130. 23 fig, 5 tab, 102 ref.

Descriptors: *Agricultural practices, *Agriculture, *Dry farming, *Farm equipment, *Tillage, *Water conservation, Herbicides, Plant growth, Productivity, Rainfall, Rainfall impact, Soil crusts, Soil physical properties, Weed control.

Tillage is performed in dryland crop production to control weeds, improve soil physical structure, prepare a seedbed, and improve soil and water conservation. Tillage systems include clean-tillage systems, stubble-mulch tillage systems, reduced-tillage systems, and no-tillage systems. With reduced tillage, herbicides are often used to control weeds, and tillage is performed to prepare a seedbed or improve soil physical properties. In low rainfall areas with marginal water supplies, reduced-tillage rather than no-tillage systems are better adapted because residue production is limited and may not be sufficient to achieve satisfactory protection of the soil surface from raindrop impact. When rainfall is greater and adequate residues can be produced to provide soil surface protection against crusting and compaction, no-tillage systems are effective. Although specialized seeding equipment may be required for reduced-tillage and no-tillage systems, equipment inventories and overall costs can be lower. The greatest need is to develop reduced-tillage or no-tillage systems that are adapted to low rainfall areas where residue production is limited or residues are grazed or removed for other purposes. (See also W91-07752) (Brunone-PTT)
W91-07757

FERTILITY MANAGEMENT AND NUTRIENT CYCLING.
Agricultural Research Service, Lincoln, NE.
J. F. Power.
IN: Dryland Agriculture: Strategies for Sustainability. Advances in Soil Science, Volume 13. Springer-Verlag New York, Inc., New York. 1990. p 131-149. 4 fig, 4 tab, 35 ref.

Descriptors: *Agricultural practices, *Available water, *Cycling nutrients, *Dry farming, *Water conservation, *Water resources management, Crop yield, Erosion control, Evapotranspiration, Growing season, Seasonal distribution, Soil erosion, Soil physical properties, Soil water.

In dryland agriculture, limited water availability is usually the factor that ultimately limits crop production. Dryland soils experience less vegetative growth, smaller quantities of nutrients taken up and returned to the soil, greater hazards of loss by erosion, and greater problems with salinity and volatilization of ammonia. Often a dryland soil experiences limited periods of both excess water and severe water deficits within the same growing season, affecting nutrient cycling processes accordingly. Good management of dryland soils mandates the use of practices that reduce evapotranspiration losses to the greatest extent possible. Residues are retained on the soil surface to reduce evaporation and runoff losses, as well as loss of nutrients through soil erosion. Planting, cultivating, fertilizing, and other production practices are timed to use most efficiently the limited available water supply. Planting rates, row spacings, and water conserving cultivars are used. (See also W91-07752) (Brunone-PTT)
W91-07758

WATER-USE EFFICIENCY.
Agricultural Research Service, Bushland, TX. Conservation and Production Research Lab.
B. A. Stewart, and J. L. Steiner.
IN: Dryland Agriculture: Strategies for Sustainability. Advances in Soil Science, Volume 13. Springer-Verlag New York, Inc., New York. 1990. p 151-173. 8 fig, 6 tab, 53 ref.

Descriptors: *Agricultural practices, *Agriculture, *Arid climates, *Available water, *Dry farming, *Infiltration, *Water conservation, *Water use efficiency, Crop yield, Productivity, Rainfall, Resources management, Runoff, Soil profiles, Soil types, Soil water, Transpiration, Water resources management.

Dryland farming is a rainfed crop production system in which the major limitation is a deficiency of water. A maximum proportion of available water should be used for transpiration with minimum losses to evaporation, drainage, and runoff. In dry climates, annual cereals and summer row crops are generally seeded at relatively low rates, with the expectation that wider spacing of the plants will lead to water being conserved for use in the later part of the season, thereby increasing the harvest index and resulting in higher grain yields. In general, stored soil water is more fully utilized at higher plant densities, resulting either from higher plant populations or decreased row spacings. Traditional cropping patterns have evolved, in part, to match the growing patterns of common crops to average climatic patterns. Farmers crop these soils only during the post-monsoon season on soil water stored in the profile. An improved watershed-based system allows both rainy season and post-rainy season cropping of Vertisols in medium to high and dependable rainfall areas (750 to 1250 mm per year with more than 70% probability that 10 mm per week of rain). This system greatly increases water-use efficiency and crop yields while significantly reducing soil erosion. The use of computer crop models holds promise for looking at the effect of seeding date on yield. Plant breeding will continue as a major focal point for increasing crop yields. Relatively few attributes directly associated with efficiency of water use are known to be under genetic control. In areas where water is occasionally stored deep in the soil profile, a deep-rooted crop may be planted periodically to extract the deep soil water. One of the keys to sound water management is adequate soil fertility to ensure the most efficient use of available water. Crop canopies with adequate fertility develop at a faster rate, leading to higher infiltration and reduced runoff. In defining the water-use efficiency of a cropping system, all economic returns (grain yields, contributions of the crop to animal production, and contributions of the crop to fertility needs of subsequent crops) must be taken into account. (See also W91-07752) (Brunone-PTT)
W91-07759

ROLE OF SOIL BIODIVERSITY IN SUSTAINABLE DRYLAND FARMING SYSTEMS.
Agency for International Development, Washington, DC.
C. S. Potter, and R. E. Meyer.
IN: Dryland Agriculture: Strategies for Sustainability. Advances in Soil Science, Volume 13. Springer-Verlag New York, Inc., New York. 1990. p 241-251. 60 ref.

Descriptors: *Agricultural practices, *Agriculture, *Dry farming, *Erosion, *Resources management, *Soil conservation, *Soil erosion, *Soil organisms, *Soil-water-plant relationships, *Water conservation, Fallowing, Microorganisms, Nutrient concentrations, Organic matter, Productivity, Soil aggregates, Soil chemistry, Soil types.

Environmental degradation has been recognized as one consequence of modern agricultural development. Land use planning requires reliable diagnostic parameters for predicting potential productivity and erodibility of various soil types. From a soil management perspective, conventional tillage reduces the size of soil aggregates, which can promote pore clogging and decreased infiltration. Total carbon and nitrogen, water-stable soil aggregates, and polysaccharides in abandoned farmlands frequently increase with time since disturbance, whereas chelating resin-extractable carbon, humic acid/fulvic acid ratios, caloric content of the root-mass, and dehydrogenase activity decrease. Studies in the drylands offer specific trends in soil microbial biodiversity associated with land management in moisture-stressed areas. In addition to microbial species sensitivity to soil management, certain soil faunal species appear to be reliable indicators of disturbance. Increased soil biodiversity is a major factor determining the efficient cycling of nutrients in agroecosystems. The purpose of fallowing in fragile lands is to allow soil organic matter levels to build up and promote microbial activity for improvement of soil structure and productivity. With intensive study and detailed measurement, microbial community composition could reveal practical information on the productive status of managed agricultural soils. (See also W91-07752) (Brunone-PTT)
W91-07761

MANAGING CROP RESIDUES TO OPTIMIZE CROP/LIVESTOCK PRODUCTION SYSTEMS FOR DRYLAND AGRICULTURE.
Agricultural Research Service, Pullman, WA.
R. I. Papendick, J. F. Parr, and R. E. Meyer.
IN: Dryland Agriculture: Strategies for Sustainability. Advances in Soil Science, Volume 13. Springer-Verlag New York, Inc., New York. 1990. p 253-272. 10 fig, 1 tab, 36 ref.

Descriptors: *Agricultural practices, *Agriculture, *Available water, *Dry farming, *Livestock, *Soil conservation, *Water conservation, *West Africa, Fallowing, Infiltration, Mali, Nutrient concentrations, Organic matter, Productivity, Rainfall, Runoff, Snow cover, Soil chemistry, Soil water, Tillage.

Improvements in crop and livestock production in the dryland regions is constrained not only by the limited supply of available water but also by the low and declining soil productivity. Crop residues represent an important potential resource for returning organic matter and conserving soil and water. Fallow efficiency is defined as the percentage of precipitation that is stored in the soil at the end of the fallow season. Relatively low amounts of residues can be effective in enhancing infiltration, but more is necessary to reduce evaporation losses. Surface residues are most effective in suppressing evaporation during the rainy season and may be of little or no benefit for this purpose during the dry season. In West Africa, runoff from

the first rains after the long dry season may exceed 70% of the rainfall amount. A rainfall simulator study conducted on a sandy soil in Mali showed that a complete cover of stiff-strawed residue over tilled soil essentially eliminated runoff from rainfall applied at 93 mm/hour for 40 minutes. This rate was maintained for much less time for the base, tilled soil, and the final infiltration rate after 60 minutes of rainfall was below 40 mm/hour for the bare soil and double this for the residue-covered soil. Experiments in the US Pacific Northwest showed that water gains were highest with a combination of paraplow tillage and surface residues and lowest with bare surface. The greatest benefit from surface residues in reducing evaporative loss occurs when the soil surface is wet and in the first stage of drying. Snow is an important source of water in the northern latitudes and if held on the fields can be more effectively stored than rain. (See also W91-07752) (Brunone-PTT)
W91-07762

AGROCLIMATIC APPROACHES FOR IMPROVING AGRICULTURAL PRODUCTIVITY IN SEMIARID TROPICS.
Georgia Experiment Station, Griffin.
E. T. Kanemasu, J. I. Stewart, S. J. van Donk, and S. M. Virmani.
IN: Dryland Agriculture: Strategies for Sustainability. Advances in Soil Science, Volume 13. Springer-Verlag New York, Inc., New York. 1990. p 273-309. 14 fig, 9 tab, 9 ref.

Descriptors: *Africa, *Agriculture, *Available water, *Climatology, *Developing countries, *Productivity, *Rainfall, *Rainfall forecasting, *Sahel, *Semiarid climates, *Sudan, *Temporal variation, *Tropic zone, Resources management, Soil conservation, Water conservation.

The semiarid tropics is a region of limited, erratic rainfall and nutrient-poor soils. The spatial and temporal variations in rainfall in the semiarid tropics are due to seasonal migrations of the equatorial trough or the intertropical convergence zone, which occurs in response to the seasonal variation in the latitude of maximum insolation. Currently in the semiarid areas, rainfall variability is on the increase. The logical and practical means to facilitate the agroclimatic approaches require the development of both hardware and software, as well as an expanded data base. In the sub-Saharan area, early warning of weather conditions is critical because the growing season is very short and most of the cropping is done by several farmers with limited means producing staple cereal of low value. Agronomists will have to work with agroclimatologists to make strategic and tactical decisions for the farmer for adopting cropping systems and crop management practices as of the onset and progress of the rainy season. This new method, called 'Response Farming', is being evaluated in the Sahel and Sudan. By properly evaluating the agroclimatic resources and transferring and adapting improved technologies, the yet underexploited potential of semiarid tropical regions can be realized for sustained and improved agriculture. (See also W91-07752) (Brunone-PTT)
W91-07763

ECONOMIC ANALYSIS OF FARM MANAGEMENT PRACTICES AND IMPROVED TECHNOLOGIES IN THE SAHEL.
Economic Research Service, Washington, DC.
J. C. Day, W. R. Butcher, and D. W. Hughes.
IN: Dryland Agriculture: Strategies for Sustainability. Advances in Soil Science, Volume 13. Springer-Verlag New York, Inc., New York. 1990. p 311-332. 2 fig, 12 tab, 38 ref, append.

Descriptors: *Africa, *Agricultural practices, *Agriculture, *Available water, *Dry farming, *Economic aspects, *Farming, *Mali, *Model studies, *Sahel, *Soil conservation, *Water conservation, *Water resources management, Crop yield, Erosion control, Fertilizers, Infiltration, Mathematical models, Rainfall, Soil erosion, Soil moisture retention, Soil water.

Various farming practices were evaluated for managing soil, water and crops to identify the most desirable combination, economically. Land, labor and capital resources available on a typical farm in western Mali helped to determine which technologies were feasible and the extent of their use. Soil moisture and soil erosion control benefits of the tied-ridge technology were explicitly taken into account. The whole-farm economic model proved to be a simple but effective tool for integrating agronomic, agroclimatic, and socioeconomic data associated with the many alternative farm production decisions examined. The complex relationship between crop yields and rainfall distribution throughout the growing season, infiltration, soil water-holding capacity, and soil water management practices was simulated with a soil water balance model. The amount and timing of rain and the capacity of the soil to collect and hold water jointly determine the amount of moisture actually available for plant uptake. Similarly, crop management can alter plant water demands to more closely match soil water availability. Even in the relatively humic Sudano-Guinean zone, improved soil and water management could lead to significant differences in farm production, income and soil erosion. The combination of chemical fertilizer and tied ridges proved most effective, as did the long-season (130 day) cultivars of food grain crops and groundnuts. The short-season (90-day) cultivars made no significant contribution to farm output or income. The benefits of public programs and policies that stimulate better soil and water management in the rainfed areas of the Sahel are potentially very large. (See also W91-07752) (Brunone-PTT)
W91-07764

USE OF CROP SIMULATION MODELS IN DRYLAND AGRICULTURE.
Texas Agricultural Experiment Station, Temple. Blackland Research Center.
C. A. Jones.
IN: Dryland Agriculture: Strategies for Sustainability. Advances in Soil Science, Volume 13. Springer-Verlag New York, Inc., New York. 1990. p 333-345. 49 ref.

Descriptors: *Agricultural practices, *Agriculture, *Australia, *Crop production, *Dry farming, *Farming, *Mathematical models, *Model studies, *Texas, *Water conservation, *Water resources management, Agricultural runoff, Dikes, Drought, Economic aspects, Evaporation, Infiltration, Irrigation, Rainfall, Runoff, Soil chemistry, Soil water, Tillage.

During the past 15 years, simulation models have been developed for a number of agricultural processes, including weather, hydrology, soil erosion, nutrient transformations and losses, and crop phenology, growth, and yield. The Australian economy has long depended on export of industrial and agricultural raw materials, and high priority has been given to adaptation of export crops to the Australian environment. Simulation models have been used to provide detailed analyses and to match crop climatic and soil requirements with site characteristics. Potential crops include guayule, sunflower, and sorghum. Simulation models have been used to study adaptation of other crops to specific sites in Australia. Simulation models have been used in novel ways to match the climatic characteristics of sites with consumer demand for fresh produce. One model estimated phenological development of the crop and tuber growth (bulking). In central Texas, rainfall is quite variable during the grain sorghum growing season, and drought stress often limits yields. Dryland farmers cannot alter the amount or timing of precipitation received by the crop, but they can often manage its utilization. Proper tillage and residue management can improve infiltration and minimize evaporation losses from the soil surface. Fallow can be used to increase stored soil water, and furrow dikes can trap runoff until it infiltrates. Simulation models have increasingly been adapted to microcomputers and included in comprehensive decision support systems containing extensive natural resource and economic data bases and expert systems. These decision support systems are being used to aid within-season crop management, including the scheduling of irrigation. (See also W91-07752) (Brunone-PTT)
W91-07765

STRATEGIES FOR INCREASING THE PRODUCTIVITY AND STABILITY OF DRYLAND FARMING SYSTEMS.
Agricultural Research Service, Beltsville, MD.
C. E. Whitman, and R. E. Meyer.
IN: Dryland Agriculture: Strategies for Sustainability. Advances in Soil Science, Volume 13. Springer-Verlag New York, Inc., New York. 1990. p 347-358. 2 fig, 8 ref.

Descriptors: *Agricultural practices, *Agriculture, *Available water, *Crop production, *Dry farming, *Government supports, *Water conservation, Arid climates, Australia, Crop yield, Environmental aspects, Erosion, Great Plains, Irrigation, Organic matter, Precipitation, Productivity, Rainfall, Semiarid climates, Soil chemistry, Wind erosion.

Most of the world's food production is achieved under rainfed conditions. That part of the rainfed sector where precipitation is generally limiting to crop production is an important and essential part of the agricultural sector in many countries. These same areas have serious environmental problems and poverty. Over the last fifty years, development in semiarid and arid regions has been largely the result of irrigation projects. While irrigation projects have substantially increased production in semiarid lands such as the US Great Plains and India, the long-term sustainability of irrigation has always been problematic. During the early to mid-1920s, rainfall on the Great Plains was favorable; farmers intensively cultivated and grazed their land. After the drought of the 1930s, the area was experiencing drastic declines in production and severe wind erosion. The US government responded to the problem with the Land Utilization Program, in which the severely eroded land was purchased by the USDA and removed from production. The southern Great Plains has now been transformed into one of the most efficient and productive grain-producing areas in the world. In southern Australia, dryland productivity has increased dramatically since the turn of the century. Initially, crop yields were increased by the use of superphosphate and wheat-fallow rotation. Continued use of these practices eventually depleted soil organic matter and resulted in deterioration of soil structure. The ley farming system (crop/livestock) has enormous potential for countries in the Near East and North Africa. Government policies and both the availability and suitability of agricultural technologies have played important roles in the recovery of dryland productivity. Future focus should be on soil and water conservation, increased biomass production, and cropping systems that maintain adequate soil cover and organic matter levels. (See also W91-07752) (Brunone-PTT)
W91-07766

PROCEEDINGS OF: SOUTH TEXAS IRRIGATION CONFERENCE.
January 11, 1990, Pearsall, Texas. Lower Colorado River Authority, Austin. 1990. 78p.

Descriptors: *Groundwater irrigation, *Irrigation efficiency, *Texas, *Water supply development, *Water use efficiency, Cost analysis, Crop production, Fertilizers, Irrigation districts, Irrigation programs, Irrigation requirements, Irrigation wells, Pesticides, Pumping, Water conservation.

The South Texas Irrigation Conference held in Pearsall, Texas on January 11, 1990 covered topics related to improving the efficiency of irrigated agriculture in Texas while reducing costs. Seven selected subjects from the conference proceedings deal with the following topics: management of groundwater through underground water conservation districts; chemigation (application of agricultural chemicals in irrigation water) equipment and safety; scientific and unscientific irrigation scheduling; quantity and timing of irrigation; economics of chemigation; low pressure precision application pivot irrigation (conversion and management); and irrigation pumping costs. The conference was sponsored by the Texas Agricultural

Extension Service and Evergreen Underground Water Conservation District. The articles contained in these proceedings are meant to serve as reference material and do not cover all topics presented by the fourteen speakers at the conference. (See W91-07801 thru W91-07806) (Geiger-PTT)
W91-07800

MANAGEMENT OF GROUNDWATER THROUGH UNDERGROUND WATER CONSERVATION DISTRICTS IN TEXAS.
Texas A and M Univ., College Station. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 4B.
W91-07801

CHEMIGATION EQUIPMENT AND SAFETY.
Texas A and M System Research and Extension Center, Amarillo.
L. L. New, and G. Fipps.
IN: Proceedings of: South Texas Irrigation Conference. Lower Colorado River Authority, Austin. 1990. p 15-33. 1 fig, 9 tab.

Descriptors: *Agricultural chemicals, *Farm equipment, *Fertilizers, *Irrigation practices, *Pesticides, *Safety, *Sprinkler irrigation, Irrigation design, Irrigation efficiency, Irrigation engineering, Irrigation operation, Irrigation scheduling.

The equipment required for chemigation (the injection of an approved chemical into irrigation water) and its safe operation in irrigation systems are described. The earliest work with chemigation involved applying fertilizers through sprinklers. Later pesticides were applied through chemigation. The advantages of chemigation include uniformity of application, precise application of chemicals where needed and in the correct concentrations, and reduced costs of applying the chemicals in irrigation water. Using chemigation chemicals can still be applied when other methods can not be used due to wetness or other factors. Chemigation reduces soil compaction and crop damage. Chemigation also offers greater operator safety because the operator is not in the field during applications and receives less contact with chemicals. Chemigation requires skill in calibration, knowledge of the irrigation and chemigation equipment, and understanding of irrigation scheduling concepts. New EPA labeling requirements mandate that labels must state how pesticides may be applied through the irrigation system. The labeling program requires use of specific safety equipment and devices which are designed to prevent accidental spills. Three types of injection units are used for chemigation: piston (positive displacement) pump, diaphragm pump, and the venturi meter. The piston pump is typically used to inject nitrogen fertilizer and usually cannot be adjusted to inject appropriate quantities of pesticides. Diaphragm pumps are used extensively for low rate chemical injection. The venturi meter operates by velocity changes in the throat of the tube that create a vacuum that pulls the chemical into the water stream. Venturi meters require a constant water supply from an external water source or may be equipped with a bypass and a small booster pump for use of water from the system. An additional pump or booster pump must be used for maintaining steady flow through the venturi at a higher pressure than the pivot. A small valve is used on the suction line to regulate the injection rate. The chemical injection pump should be calibrated to apply the appropriate quantity of chemical per acre. Some labels that approve chemicals for chemigation specify the amount of water to be applied in conjunction with the chemical. The number of gallons of water per minute the center pivot applies will govern the center pivot travel speed. (See also W91-07800) (Geiger-PTT)
W91-07802

SCIENTIFIC AND UNSCIENTIFIC IRRIGATION SCHEDULING.
Texas A and M Univ., College Station. Dept. of Agricultural Engineering.
M. J. McFarland.
IN: Proceedings of: South Texas Irrigation Conference. Lower Colorado River Authority, Austin. 1990. p 34-39.

Descriptors: *Crop production, *Irrigation efficiency, *Irrigation practices, *Irrigation scheduling, *Remote sensing, Evaporation, Evapotranspiration, Infrared imagery, Irrigation programs, Root zone, Soil moisture retention, Soil water, Transpiration, Water deficit.

Irrigation scheduling involves determining when to irrigate a crop and how much water to apply. If adequate supply of water is available, the objective of irrigation scheduling is to supply just enough water to the root zone to meet the needs of the crop. The irrigation interval is determined by the available soil moisture stored in the root zone and the depletion rate set by the weather. If sufficient irrigation water is available, a common irrigation strategy is to never let the crop encounter moisture stress. Irrigation scheduling in this case is the process of applying enough water to restore the soil moisture of the root zone to field capacity. The depletion of the soil moisture in the root zone is monitored by visual or hand analysis of soil samples or use of moisture measurement devices such as tensiometers, resistance blocks, and neutron probes. Deficit irrigation is used when the water supply is not sufficient to meet the crop water requirements during normal weather conditions. Irrigation scheduling for deficit irrigation is normally done by watering at critical periods during crop growth. The effects of rain complicates irrigation scheduling because the amount of rain entering the root zone is difficult to measure and all the rain falls on all the field at the same time, where irrigation is applied to one set location at a time. Besides soil moisture, irrigation scheduling can be based on other determinations such as calendar methods which ignore crop stage or weather, plant appearance when the crop shows signs of moisture stress, pan evaporation and atmospheric methods which calculate evaporation and evapotranspiration, or remote sensing using thermal infrared imagery of crop transpiration. combinations of these methods are also helpful in determining irrigation schedules. (See also W91-07800) (Geiger-PTT)
W91-07803

IRRIGATION: HOW MUCH AND WHEN.
Texas A and M Univ., College Station. Dept. of Agricultural Engineering.
G. Fipps.
IN: Proceedings of: South Texas Irrigation Conference. Lower Colorado River Authority, Austin. 1990. p 40-46. 1 fig.

Descriptors: *Irrigation efficiency, *Irrigation practices, *Irrigation scheduling, *Soil moisture retention, *Soil water, Available water, Field capacity, Root zone, Soil texture, Wilting point.

It is difficult for many farmers to decide how much irrigation water to apply to their crops. Not applying enough water results in poor yields, while applying too much is not only a needless expense, but also wastes a scarce resource. In addition, overwatering may flush nutrients out of the root zone, thereby making the nutrients unavailable to plants and possibly contributing to groundwater pollution. The purpose of irrigating is to fill the soil pores with water in the root zone. The amount of water that a given volume of soil can hold depends on the soil texture. Several terms simplify the relationship between soil texture, soil moisture content, and irrigation requirements, namely field capacity, permanent wilting point, available water, allowable water depletion, and efficiency. Field capacity is the amount of water a soil will hold against gravity when allowed to drain freely. Permanent wilting point is the soil moisture content at which plants permanently wilt. Available water is the amount of water that can be held in the soil between field capacity and the permanent wilting point. The allowable water depletion is the amount of available water that can be depleted from the soil without adverse effects on plant growth and crop yield. The irrigation efficiency is the ratio of the amount of the applied water which becomes available to the crop divided by the total amount applied. Determining how much water to apply is a matter of estimating the amount of water needed to bring the soil moisture in the root zone up to field capacity. The following factors are measured or estimated: depth of the root zone, the water holding capacity of the soil, the amount of water currently held in the soil, and the application efficiency of the irrigation system being used. Water should be applied before the soil moisture falls below the level where damage to the plants or yield reduction occurs. The total time to irrigate is determined using the water delivery rate. Examples for calculating how much water to apply and references for more efficient irrigation practices are given. (See also W91-07800) (Geiger-PTT)
W91-07804

LEPA CONVERSION AND MANAGEMENT.
Texas A and M Univ., College Statior.. Dept. of Agricultural Engineering.
G. Fipps, and L. L. New.
IN: Proceedings of: South Texas Irrigation Conference. Lower Colorado River Authority, Austin. 1990. p 53-60.

Descriptors: *Agricultural water, *Irrigation efficiency, *Irrigation engineering, *Irrigation practices, *Spray irrigation, *Water conservation, Crop production, Soil water.

Low Pressure Precision Application (LEPA) irrigation is one of the most efficient center pivot irrigation methods available today. LEPA discharges water through pressure-regulated nozzles located from 8 to 18 inches above the furrow. This low discharge point greatly reduces spray and drift losses caused by wind, low relative humidity and high temperatures. LEPA heads are designed to operate at 6 psi, lower than most low pressure drops and much lower than that of high pressure impacts. Experimental work with LEPA showed that LEPA heads could be placed in every other furrow without any crop reduction. Placing heads in every other furrow reduces conversion costs. The LEPA head is designed to operate in three modes: the bubble mode, the horizontal spray mode, and the chemigation mode. The bubble mode is the normal mode of operation and provides the full advantages of increased irrigation efficiency. The horizontal spray mode is useful for pre-irrigations, crop germination, and chemigation of low profile crops. The chemigation mode is designed to spray the water/chemical mixture up into the canopy of high profile crops such as corn. Additional plumbing is needed for conversion to LEPA. Two methods can be used for installing drops: using existing outlets with tees and clamps, or adding additional outlets. To use existing outlets, specially designed clamps are attached to the center pivot mainline. New outlets can be quickly installed using a Swedge Coupling. Planting in a circle is recommended with the LEPA system to reduce runoff and improve the distribution of water into the soil. Scheduling irrigations using soil moisture monitoring devices is recommended because the ground will be wetter with the LEPA system than with a conventional irrigation system. LEPA pressure regulators require at least 9 psi to operate properly. To ensure adequate pressure, a pressure gauge is installed in the last drop at the end of the pivot. (See also W91-07800) (Geiger-PTT)
W91-07805

IRRIGATION PUMPING COSTS.
J. C. Henngeler.
IN: Proceedings of: South Texas Irrigation Conference. Lower Colorado River Authority, Austin. 1990. 61-78. 2 fig, 8 tab.

Descriptors: *Cost analysis, *Energy costs, *Irrigation efficiency, *Pumping, Electric power costs, Maintenance costs, Operating costs.

To reduce irrigation water pumping costs, the irrigation efficiency may be improved, the system may be converted to one that operates at lower pressure, the efficiency of the pumping plant may be improved, a less expensive fuel source may be used or the electricity service costs may be reduced by using load management incentives from

the service company. The costs of pumping water are directly related to the energy consumed which is measured in terms of work or horsepower. The only way for the farmer to reduce horsepower consumed is to reduce the total dynamic head by reducing operating pressures. The costs of pumping consists of both fixed costs (pump, engine, well, etc.) and the variable or operating costs (labor, repairs, maintenance, fuel, etc.). Fixed costs should not be viewed as initial expenditures but should be examined over the life of the equipment due to depreciation. Repair and maintenance of equipment and fuel costs are all part of variable costs. The variable cost for pumping water, whether by electricity, diesel, propane or natural gas is based on several factors: the energy content of the fuel, the expected engine or motor efficiency including drive method used, pump efficiency, and fuel cost. Additional variable costs are the associated labor and maintenance costs. The largest variable cost, the fuel cost, may be estimated per acre-inch of water as $.01 per foot of lift and $.03 per psi of pressure. To estimate labor and maintenance costs, good record keeping or use of the manufacturer's recommendations on maintenance schedules for estimating the number of input tasks per year and their costs are recommended. When all the fixed costs and variable costs are considered, then the cost of pumping water using electricity, natural gas, and diesel fuel is estimated at $4.91, 4.28, and 4.91/acre-inch, respectively. (See also W91-07800) (Geiger-PTT)
W91-07806

IRRIGATED FORESTRY IN ARID AND SEMI-ARID LANDS: A SYNTHESIS.
International Development Research Centre, Ottawa (Ontario).
F. B. Armitage.
Report No. IDRC-234c, 1985. 160p, 6 tab, 233 ref, 4 append.

Descriptors: *Arid lands, *Forestry, *Forests, *Irrigation, *Irrigation practices, *Semiarid lands, Economic aspects, Social aspects, Water resources management.

Use of irrigation in forest plantations in many arid and semiarid areas since the 1860s has demonstrated, in some cases, a potential for high wood yields and thus for countering the depletion of meager natural wood resources, with related environmental degradation, that stems from population increases. This report is aimed at enhancing irrigated forestry through an examination of past experience, the range of inputs required, and the benefits of integrating tree plantations with irrigated agriculture. It reviews the potential for irrigated forest plantations and provides a checklist of economic, sociological, and technical criteria needed to guide decisions as to the feasibility of such developments. Actions to be covered in the planning, implementation, and operational phases of irrigated forest plantations are indicated as are illustrative production levels and research needs. The closing chapters review the approaches in economic analysis, management, and planning. (Author's abstract)
W91-07905

IRRIGATION TECHNOLOGY AND COMMERCIALIZATION OF RICE IN THE GAMBIA: EFFECTS ON INCOME AND NUTRITION.
International Food Policy Research Inst., Washington, DC.
J. Von Braun, D. Puetz, and P. Webb.
Research Report 75, August 1989. 116p, 7 fig, 58 tab, 72 ref, append.

Descriptors: *Crop production, *Economic aspects, *Gambia, *Income, *Irrigation, *Nutrition, *Rice, Agriculture, Developing countries, Diets, Policy making, Public policy, Rural areas.

A new rice irrigation project was conducted which involved about 7,500 farmers in The Gambia. This study site was selected because households could be traced during and after the introduction of new rice production technology (mechanical pump irrigation and improved drainage for rainfed and tidal irrigation). The empirical research is based on a detailed sample survey of 900 farmers in 10 villages. Average and marginal labor productivities are assessed in the context of the production system for the major crops. Most farmers at the project location grow both irrigated rice and upland crops. The expansion of modern irrigation has pulled labor away from the upland crops, causing a loss of 531 calories in other crops for every 1,000 calories gained in rice production--a net gain of 47%. Less of this new rice crop is sold for cash than expected--12% of total production from pump irrigation and 7% from partly water controlled land. Average annual per capita income in the study area was $116 in 1985/86; agricultural income contributed 77.5%. At the sample average, the rice in the project increased real incomes by 13.0%/household. From a food security perspective, a wide distribution of small irrigated rice plots is needed across households and village communities in the area to reduce the adverse effects of seasonality and consecutive drought years on consumption. Such scattered distribution of the highly productive irrigated land results, however, in fluctuating yields, since in years of good rainfall labor is allocated more heavily to upland farming, while in drought years labor shifts more to the irrigated fields. Efforts to solve the nutrition problem can be furthered through more effective rural health service and sanitation (that is, drinking water) at the community level. (Lantz-PTT)
W91-07908

IRRIGATION AND FLOOD/EROSION CONTROL AT HIGH ALTITUDES IN THE ANDES.
International Inst. for Land Reclamation and Improvement, Wageningen (Netherlands).
For primary bibliographic entry see Field 4D.
W91-07909

IRRIGATION PERFORMANCE ASSESSMENT AND IRRIGATION EFFICIENCY.
International Inst. for Land Reclamation and Improvement, Wageningen (Netherlands).
W. Wolters, and M. G. Bos.
Annual Report 1989. International Institute for Land Reclamation and Improvement, Wageningen, The Netherlands. 1989. p 25-37, 3 fig, 15 ref, append.

Descriptors: *Irrigation efficiency, *Irrigation programs, *Performance evaluation, *Water resources management, Agriculture, Crop production, Irrigation, Water use.

The world population continues to grow and has to be fed. About 35% of the world's food is produced on irrigated lands. This percentage could be increased by enlarging the area served by irrigation and by intensifying crop growth on the already irrigated lands. If the factors that limit crop production are known, than those limitations can be lifted and crop production can be raised. Raising irrigation efficiency can be instrumental in raising crop production because a larger area can be irrigated with the same volume of water, or a water shortage can be made less severe. An efficiency is generally defined as the dimensionless ratio of output over input. An irrigation efficiency was first defined as: 'The ratio of irrigation water transpired by the crops of an irrigation farm or project during their growth period, over the water diverted from a river or other natural source into the farm project canal or canals during the same period of time'. Raising irrigation efficiency can have one or more of the following benefits: (1) a larger area can be irrigated with the same volume of water; (2) a water shortage can be made less severe; (3) investment costs for drainage to control waterlogging and salinity can be saved or reduced; (4) competition with other water users can be reduced; and (5) energy can be saved. A very high efficiency, however, can have its disadvantages: (1) salinity in the top soil may increase; (2) the water supply to part of the command area may be too low; (3) it may lead to social unrest between farmers with sufficient water and those without. Measured efficiency values should be compared with a target value and not with 100%. On-site case studies, in a variety of climatological, technical, and socioeconomic conditions, are needed to establish these target values. (Lantz-PTT)
W91-07910

WATER DISTRIBUTION: CONFLICTING OBJECTIVES OF SCHEME MANAGEMENT AND FARMERS.
International Inst. for Land Reclamation and Improvement, Wageningen (Netherlands).
For primary bibliographic entry see Field 6D.
W91-07911

TOWARDS SITUATION-SPECIFIC MANAGEMENT IN IRRIGATION.
International Inst. for Land Reclamation and Improvement, Wageningen (Netherlands).
P. N. G. Van Steekelenburg.
Annual Report 1989. International Institute for Land Reclamation and Improvement, Wageningen, The Netherlands. 1989. p 47-62, 2 fig, 1 tab, 12 ref.

Descriptors: *Developing countries, *Irrigation management, *Water resources management, Agriculture, Institutions, Irrigation practices, Niger, Rural areas.

To arrive at situation-specific management for irrigation development, one has to consider all different (levels of) actors and all steps in project preparation, implementation, and operation. A top-down working method is recommended, starting with a definition of the framework of the national irrigation-development policy--which should be consistent with the general rural-development orientation of the country--and ending with the farmer. This is not a once-only process. In this way, the target-group orientation is secured while at the same time the issue of sustainability is addressed. As an institution, an irrigation agency has to be analyzed and revised, in relation to its tasks, the farmers' needs, and its socioeconomic and political environments, with their inherent but varying degree of uncertainty. Irrigation agencies should be converted from mechanistic and input-oriented agencies toward adaptive and output-oriented agencies. A case study in Niger shows that this can be done, and that the results are attractive to all parties involved, to the farmers in particular. As the environment changes (farmer groups become more experienced; new developments take place in the private sector, etc.), agencies will have to adapt to these changes. Different project stages require varying capabilities, especially the change from the construction of the system to its full exploitation and its support to farmers for their agricultural production. In the process of diagnosing and preparing changes for institutional strenghtening, monitoring and evaluation are indispensible management tools; organization theory offers other interesting tools to help in this process. And last, a firm political commitment to the need for change is a necessary condition for all efforts to change and strengthen irrigation agencies. (Lantz-PTT)
W91-07912

NUMERICAL MODELS IN DESIGNING TUBE-WELL IRRIGATION AND DRAINAGE OF AN AQUIFER WITH A FRESH/SALT INTERFACE.
Euroconsult, Arnhem (Netherlands).
For primary bibliographic entry see Field 4B.
W91-07957

EVALUATION OF THE ECOLOGICAL AND WATER MANAGEMENT SITUATION IN CENTRAL ASIA BASED ON DATA OF AERIAL AND SATELLITE SURVEYS.
V. S. Altunin, E. I. Kupriyanova, V. A. Kharitonov, and L. A. Khrapkova.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 5, p 324-328, 1990. 1 fig, 1 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 5, p 37-40, May, 1990.

Descriptors: *Agricultural water, *Asia, *Environmental effects, *Irrigation effects, *Remote sensing, *Water conservation, *Water management, Aerial photography, Saline soils, Satellite technology, Surveys, USSR, Water resources management.

Data obtained by aerial and satellite remote sensing made it possible to record water bodies formed by collector-drain waters, the direction of discharges of water from irrigated lands, zones of seepage, outflows of irrigation waters onto the surface in the form of lakes, and the formation of secondary saline soils. A considerable part of the nonproductive losses of water in Central Asia was found to be related to the irrigation of unsuitable lands, primarily severely saline soils. It was calculated that removal of the severely salinized part of the irrigated lands of Central Asia for the purpose of reconstruction of the irrigation and drainage systems would save about 30-35 cu km of water. The volume of water nonproductively discharged to drainage areas outside of the irrigated zones amounts to 8.6 cu m/yr in the Amu Darya basin and 1.5 cu km/yr in the Syr Darya basin. A diagrammatic map revealed a chain of seepage lakes along the route of the Kara-Kum canal. Aerial and satellite surveys have further indicated an over-watering of crops in Central Asia by 30-50% of the planned withdrawal of water. A total of more than 40 cu km/yr is expended ineffectively in irrigation agriculture. A system of pipelines or flumes is recommended for delivering water to the Aral Sea, including irrigation return waters accumulating in relief depressions. (MacKeen-PTT)
W91-08034

IRRIGATION FREQUENCY EFFECTS ON LEACHING OF CATIONS FROM GYPSUM AMENDED COASTAL PLAIN SURFACE SOILS.
Citrus Research and Education Center, Lake Alfred, FL.
A. K. Alva, G. J. Gascho, and W. A. Cromer.
Water, Air and Soil Pollution WAPLAC, Vol. 52, No. 3/4, p 325-336, 1990, 4 fig, 1 tab, 27 ref.

Descriptors: *Agricultural practices, *Calcium, *Gypsum, *Irrigation effects, *Leaching, *Peanuts, Distribution patterns, Nutrient transport, Soil amendments, Soil chemistry, Soil properties, Soil types.

In low calcium soils, gypsum is applied at flowering of peanut to insure adequate availability of Ca in the fruiting zone (0 to 8 cm soil depth) during pod development. Effects of 15.2 cm water applied as 1, 2, 4 or 12 split applications over a 28 day period following the application of gypsum on the distribution of Ca and other cations in the fruiting zone and immediately below the fruiting zone (8 to 16 cm depth) were investigated on the Lakeland and Tifton soils under controlled conditions in rainout shelter plots. In Lakeland soil, the fruiting zone Ca concentration was greater for the high frequency (15.2 cm in 4 or 12 split applications) irrigation treatments than for the low frequency (15.2 cm in 1 or 2 split applications) treatments at 7 days. Those differences became non-significant after 14 days. In Tifton soil, leaching of Ca below the fruiting zone was significantly greater for the low frequency irrigation treatments than for the high frequency treatments throughout the duration of this experiment. High frequency irrigation of moderate quantities should result in low calcium losses from the fruiting zone for both soils. The gypsum-induced leaching of potassium or magnesium was lower in high frequency irrigation treatments than in low frequency treatments. High frequency irrigation following gypsum application resulted in a decrease in soil pH during the initial 7 days. (Author's abstract)
W91-08121

4. WATER QUANTITY MANAGEMENT AND CONTROL

4A. Control Of Water On The Surface

SIMULTANEOUS, MULTIPLE-LEVEL WITHDRAWAL FROM A DENSITY STRATIFIED RESERVOIR.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
For primary bibliographic entry see Field 8B.
W91-07211

HERBICIDES IN WATER: ECONOMICS OR ENVIRONMENT.
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
K. H. Bowmer.
Technical Memorandum 90/4, June 1990. 19p, 1 fig, 1 tab, 42 ref.

Descriptors: *Aquatic weeds, *Environmental impact, *Herbicides, *Water quality, *Water resources development, *Weed control, Aquatic plants, Ecological effects, Elodea, Erosion control, Toxicity, Water hyacinth.

The use of herbicides and risks of water pollution are reviewed, and water quality criteria are described for different uses of water. This approach can be criticized because of the paucity of data for irrigated crops, sensitive aquatic plants and community ecosystems; lack of information for some herbicides and breakdown products; complications of influence of other water quality parameters and other toxicants; and inappropriate use of concentration rather than pattern of exposure. Notwithstanding the difficulties in assessing the risks of water pollution, it is argued that there are substantial benefits of herbicide use in protecting soil and water resources. These include use in cropping systems to improve soil stability, reduce erosion and ameliorate eutrophication problems; use in aquatic weed control to maintain supply and drainage in irrigation systems, and to prevent flooding in coastal areas; and use in the preventative management of aggressive introduced plants such as Elodea canadensis, Eichhornia crassipes, Alternanthera philoxeroides and Mimosa pigra. (Author's abstract)
W91-07220

STUDY OF INNOVATIVE TECHNIQUES TO REDUCE SUBSURFACE DRAINAGE FLOWS.
Lord (J.M.) Inc., Fresno, CA.
For primary bibliographic entry see Field 5G.
W91-07223

RIO PUERTO NUEVO FLOOD-CONTROL PROJECT, SAN JUAN, PUERTO RICO: HYDRAULIC MODEL INVESTIGATION.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
For primary bibliographic entry see Field 8B.
W91-07245

ICE JAM MITIGATION.
Cumming Cockburn Ltd., Willowdale (Ontario). Water Resources Div.
For primary bibliographic entry see Field 2C.
W91-07522

KRIGING TECHNIQUE FOR RIVER FLOOD REPRESENTATION (LE KRIGEAGE DUAL, UNE TECHNIQUE POUR LA CARTOGRAPHIE AUTOMATISEE DES ZONES D'INONDATION).
Ecole Polytechnique, Montreal (Quebec). Groupe de Recherche CASTORPLUS.
For primary bibliographic entry see Field 7B.
W91-07603

CASE STUDIES IN DRAINAGE AND LEVEE DISTRICT FORMATION AND DEVELOPMENT ON THE FLOODPLAIN OF THE LOWER ILLINOIS RIVER, 1890S TO 1930S.
Illinois Univ. at Urbana-Champaign. Dept. of Geography.
For primary bibliographic entry see Field 6F.
W91-07816

SUBSTANTIATION OF PARAMETERS OF FLOOD CONTROL ENGINEERING OF THE NORTHEAST COAST OF THE CASPIAN SEA.
For primary bibliographic entry see Field 8A.
W91-07877

ENHANCED BIOLOGICAL CONTROL OF WATERHYACINTH FOLLOWING LIMITED HERBICIDE APPLICATION.
Florida Univ., Gainesville. Dept. of Entomology.
K. H. Haag, and D. H. Habeck.
Journal of Aquatic Plant Management JAPMDB, Vol. 29, p 24-28, January 1991. 2 fig, 2 tab, 23 ref.
USDA, ARS Cooperative Agreement 58-7B30-3-570.

Descriptors: *Aquatic weed control, *Biocontrol, *Herbicides, *Water hyacinth, Aquatic weeds, Florida, Insects, Lakes, Water lettuce, Weevils.

Eighty percent of Calf Pond, a 6-ha lake in north central Florida, was sprayed incrementally beginning in August 1985 with the herbicide 2,4-D to gradually reduce the surface coverage of waterhyacinth. Herbicide treatments occurred at 3 to 4 week intervals, and approximately 15% of the lake was treated on each date. The remaining untreated plants were surrounded by a floating barrier along one shore and left in the lake to serve as a reservoir for waterhyacinth weevils, which were present at an initial mean density of 3.2 adult weevils/sq m. Weevil production in October 1986 raised the weevil density to 3 times that observed in October 1985 and the number of feeding scars was twice that observed in December 1985. The resultant heavy feeding damage reduced plant density and biomass severely, and by April 1987 no live waterhyacinth plants remained in the lake. Calf Pond was subsequently invaded by waterlettuce, and as of November 1990 was extensively colonized by this aquatic weed. (Author's abstract)
W91-08072

IN VITRO PROPAGATION AND BIOASSAY SYSTEMS FOR EVALUATING GROWTH REGULATOR EFFECTS ON MYRIOPHYLLUM SPECIES.
Florida Univ., Gainesville. Inst. of Food and Agricultural Sciences.
M. E. Kane, and E. F. Gilman.
Journal of Aquatic Plant Management JAPMDB, Vol. 29, p 29-32, January 1991. 6 fig, 25 ref.

Descriptors: *Aquatic weed control, *Bioassay, *Culturing techniques, *Laboratory methods, *Myriophyllum, Culture media, Herbicides.

In vitro culture procedures were developed for efficient propagation of Myriophyllum aquaticum, M. heterophyllum, M. pinnatum, M. spicatum, and M. 'Frill' for use in growth regulator screening studies. Shoots formed rapidly and grew into dense multiple shoot masses in all species cultured on a shoot multiplication medium consisting of Murashige and Skoog mineral salts (MS) supplemented with 0.56 mM myo-inositol, 1.2 microM thiamine-HCL, 87.6 mM sucrose, and 30 microM N-(3-methyl-2-butenyl)H-purin-6-amine) (2iP) solidified with 0.8% (w/v) agar. Shoots of M. heterophyllum were stored in vitro for 14 months at 5 C without loss of regenerative capacity. Single rooted submerged shoots of each species were produced by subdividing the shoot masses and subculturing in liquid half-strength MS supplemented with 0.56 mM myo-inositol, 1.2 microM thiamine-HCL, and 87.6 mM sucrose for two 6-day culture cycles. M. heterophyllum, M. 'Frill,' and M. spicatum exhibited interspecific differences in sensitivities to the growth retardant Cycocel. Potential applications of these culture protocols for further growth regulator screening are discussed. (Author's abstract)
W91-08073

EFFICACY OF EARLY-SEASON FLURIDONE TREATMENT FOR MANAGEMENT OF WATERMEAL, WOLFFIA COLUMBIANA KARST.
North Carolina State Univ. at Raleigh. Dept. of Crop Science.
S. H. Kay.
Journal of Aquatic Plant Management JAPMDB, Vol. 29, p 42-45, January 1991. 1 tab, 7 ref. North

Carolina Agricultural Research Service Project NC05671.

Descriptors: *Aquatic weed control, *Fluridone, *Herbicides, Aquatic weeds, Flushing, Ponds.

Three fluridone formulations (4AS, 5P, and SRP) were applied at maximum label rates in mid-March to late March and early April of 1988 and 1989 to evaluate early-season treatments for control of watermeal in ponds. The 4AS and 5P formulations effectively suppressed watermeal in 1988, and all three were effective in 1989. After treatment, watermeal continued to spread on all ponds until July and declined gradually thereafter. Treatment in early summer with 4AS either with or without a surfactant substantially suppressed growth by July, but some watermeal persisted until the end of the season. Hydraulic flushing during the first three weeks after treatment reduced efficacy in many ponds treated in 1989 and was solely responsible for the persistence of watermeal into the 1990 season in these ponds. (Author's abstract)
W91-08075

PHYSICAL DESCRIPTION OF WATER HYACINTH MATS TO IMPROVE HARVESTER DESIGN.
British Columbia Univ., Vancouver. Dept. of Bio-Resource Engineering.
R. J. Petrell, L. O. Bagnall, and G. H. Smerage.
Journal of Aquatic Plant Management JAPMDB, Vol. 29, p 45-50, January 1991. 10 fig, 3 tab, 5 ref.

Descriptors: *Aquatic weed control, *Aquatic weeds, *Water hyacinth, Buoyancy, Density, Floating plants, Population density.

More efficient water hyacinth (Eichhornia crassipes) harvesting methods can result from equipment designs based on a better understanding of the physical characteristics of mats that affect machine performance. For this purpose, descriptions or ranges of the following physical characteristics of water hyacinths were determined for plants obtained from different habitats: plant size distribution, rhizome length, areal density, and connectivity. Connectivity, a new property, is a measure of plant entanglement by petioles and stolons. Plant mass was normally distributed in established mats of water hyacinth and not in mats of small plants or plants subjected to regular harvesting. Rhizome length was correlated with plant mass. Population density was correlated with average plant height and biomass density. Connectivity and buoyancy are independent properties that define the mechanics of vertical plant support. A plant entangled with other plants is erect due mostly to its connectivity, while a free-floating plant is erect when it develops leaves with floats. (Author's abstract)
W91-08076

INTRODUCTION OF NEOHYDRONOMUS AFFINIS FOR BIOLOGICAL CONTROL OF PISTIA STRATIOTES IN ZIMBABWE.
Plant Protection Research Inst., Harare (Zimbabwe).
G. P. Chikwenhere, and I. W. Forno.
Journal of Aquatic Plant Management JAPMDB, Vol. 29, p 53-55, January 1991. 1 fig, 8 ref.

Descriptors: *Aquatic weed control, *Biocontrol, *Water lettuce, *Weevils, *Zimbabwe, Adult growth stage, Aquatic plants, Aquatic weeds, Food habits, Insects, Manyame River, Rivers, Roots.

Experiments were carried out to test the effect of the weevil Neohydronomus affinis on growth of water lettuce (Pistia stratiotes) in Zimbabwe. The adult feeding tests, effect of the weevil on plant growth, and establishment of the weevil in the field are described. In both choice (with one exception) and no-choice feeding tests, adults fed only on water lettuce. In plant growth tests, after six weeks of feeding damage by the weevil, most plants had rotted and sunk to the bottom of the container, leaving only daughter plants. By the second month, the length of the longest root on the weevil-infested plants was less than half the length of that in the control, and leaves were shorter. Daughter plants failed to grow to the size of normal parent plants and were much smaller than the daughter plants in the insect-free treatments. Field observations indicated that the weevil was well established in the Manyame River by July 1988, 4 months after its first release there. Many plants were severely damaged, plant size was declining, and other aquatic plants had begun to invade the area. By February 1989, less than 12 months after the release of N. affinis, water lettuce was no longer a problem in the Manyame River. (Doria-PTT)
W91-08078

EFFECTS OF HERBICIDES AND MICROBIAL INSECTICIDES ON THE INSECTS OF AQUATIC PLANTS.
Florida Univ., Gainesville. Dept. of Entomology and Nematology.
K. H. Haag, and G. R. Buckingham.
Journal of Aquatic Plant Management JAPMDB, Vol. 29, p 55-57, January 1991. 1 tab, 14 ref. USDA, ARS Cooperative Agreement 58-7B30-3-570.

Descriptors: *Aquatic insects, *Aquatic weed control, *Biocontrol, *Herbicides, *Insects, *Pesticide toxicity, Adult growth stage, Aquatic weeds, Bacillus, Bacteria, Copper, Diquat, Endothall, Flies, Fluridone, Fungi, Growth stages, Habitats, Hydrilla, Larval growth stage, Mortality, Statistical analysis, Water lettuce, Weevils.

The impacts of selected herbicides and microbial pesticides on native and introduced biocontrol insects of water lettuce and hydrilla were investigated. The bacterial pesticide Bacillus sphaericus caused significant mortality of larvae of the native moth Parapoynx diminutalis, whereas B. thuringensis israelensis application resulted in significant mortality of larvae of the moth Synclita obliteralis. The fungus Lagenidium did not cause statistically significant mortality of any insect species tested. The weevil Bagous affinis adults did not experience significant mortality when exposed to low or high concentrations of diquat dibromide and chelated copper, endothall, or fluridone. Hydrellia fly larvae suffered significant mortality when treated with 4 and 8 ppm endothall; and 4.6 and 9.2 ppm fluridone; and 90 ppm diquat dibromide + 38 ppm chelated copper. With the exception of the endothall tests, these herbicides were evaluated at concentrations considerably higher than those normally used in the field. The high rate of death for Hydrellia may be due to loss of habitat following death of hydrilla leaflets rather than direct toxicity of the herbicides. If herbicide is applied in an integrated management program against hydrilla, it may be important to avoid times of the year when fly larvae and pupae are present and vulnerable to habitat loss. (Doria-PTT)
W91-08079

4B. Groundwater Management

STUDY OF INNOVATIVE TECHNIQUES TO REDUCE SUBSURFACE DRAINAGE FLOWS.
Lord (J.M.) Inc., Fresno, CA.
For primary bibliographic entry see Field 5G.
W91-07223

GROUND-WATER CONDITIONS IN UTAH, SPRING OF 1990.
Geological Survey, Salt Lake City, UT. Water Resources Div.
For primary bibliographic entry see Field 6D.
W91-07246

RELIABILITY OF A GROUNDWATER MODEL: THE HISTORY OF MODELLING THE JWANENG NORTHERN WELLFIELD IN BOTSWANA.
Anglo American Corp. of South Africa Ltd., Marshalltown.
For primary bibliographic entry see Field 2F.
W91-07284

SEQUENTIAL APPROACH TO GROUNDWATER MONITORING AND MANAGEMENT.
Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.
R. Andricevic.
IN: ModelCARE 90: Calibration and Reliability in Groundwater Modelling. IAHS Publication No. 195. International Association of Hydrological Sciences, Washington, DC. 1990. p 489-499. 3 fig, 1 tab, 14 ref.

Descriptors: *Groundwater management, *Hydraulic head, *Management planning, *Model studies, *Monitoring, *Operating policies, *Optimization, *Water demand, *Water resources management, Calibrations, Data interpretation, Differential equations, Flow models, Geohydrology, Groundwater movement, Groundwater resources, Hydraulic conductivity, Hydrologic models, Mathematical analysis, Mathematical studies, Numerical analysis, Prediction, Simulation, Statistical analysis, Statistical methods, Uncertainty, Water level.

The management of groundwater hydraulics is used to evaluate operational policies or groundwater withdrawal strategies for managing groundwater resources. A common approach is to couple an optimization model with a simulation model of groundwater flow. A sequential groundwater management model was structured as a discrete time optimal control problem which identifies the optimal withdrawal rates by satisfying a penalty type cost function of the two conflicting objectives: satisfying withdrawal demands and maintaining target hydraulic head levels. A control action, obtained in feedback form, depends on the future uncertainty in the hydraulic head prediction which is due to the variability in the hydraulic conductivity. The hydraulic conductivity field is updated in 'real time', as new field observations become available. A numerical example used to demonstrate the sequential approach revealed that a real time design of the monitoring program for the hydraulic conductivity field should be guided based on the areas of high hydraulic head gradient, since the information from these areas will eventually lead to the most reliable management strategy. In addition, a potential bias in the management solution, due to the uncertainty in the objective function was revealed. In practice, increased emphasis is needed on identifying the objective function coefficients, regardless of the sophistication level of the management algorithm. (See also W91-07253) (Korn-PTT)
W91-07301

EVALUATION OF THE RESPONSE OF A WATER TABLE TO A VARIABLE RECHARGE RATE.
K.N. Toossi Univ. of Technology, Tehran (Iran). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2F.
W91-07628

PROCEEDINGS OF: SOUTH TEXAS IRRIGATION CONFERENCE.
For primary bibliographic entry see Field 3F.
W91-07800

MANAGEMENT OF GROUNDWATER THROUGH UNDERGROUND WATER CONSERVATION DISTRICTS IN TEXAS.
Texas A and M Univ., College Station. Dept. of Agricultural Engineering.
D. L. Reddell, and J. M. Sweeten.
IN: Proceedings of: South Texas Irrigation Conference. Lower Colorado River Authority, Austin. 1990. p 1-14. 1 tab, 1 ref.

Descriptors: *Agricultural water, *Groundwater management, *Groundwater mining, *Irrigation districts, *Texas, *Water conservation, *Well regulations, Aquifers, Irrigation wells, Tailwater, Water pollution prevention, Water quality, Water use efficiency, Well permits.

In 1949, the Texas law allowed Legislature provided for the creation and operation of underground

water conservation districts. These districts have significantly modified Texas common law rule of capture regarding groundwater use. Today 22 districts cover most major aquifers in the state. The districts have slowed water table declines and improved water quality utilizing well permits, well spacing rules, public education, water conservation, and pollution control rules. The High Plains Underground Water Conservation District No. 1 (HPUWCD) in Lubbock, Texas is examined as an example of an underground water conservation district. HPUWCD became the first underground water conservation district in 1951. In 1980 the district had 96.7 million acre feet of recoverable water in storage, which was about 25% of the recoverable groundwater in the Ogallala aquifer in Texas. The HPUWCD is governed by a five-member Board of Directors elected for a two year term. Each county in the district has an elected five-member County Committee. The district's activities are financed through a valuation advalorem tax plus special fees for some services. All landowners must obtain a permit to drill a well that exceeds 25,000 gpd in capacity. The permitted well must be spaced from all existing wells depending on the column pipe size of the pump. The district has a rule against waste and has defined tailwater runoff from irrigation as a waste. HPUWCD initiated an extensive public education and personnel contact program to educate irrigators about tailwater. In addition they have issued hundreds of cease-and-desist orders to stop tailwater, and have taken steps to enjoin numerous irrigators wasting water through tailwater runoff. In 1957, the district instituted a rule prohibiting the disposal of salt water produced with oil and gas into unlined surface evaporation pits. In 1966, the district initiated a program to collect and analyze water samples in numerous wells distributed uniformly throughout the district to establish a baseline water quality program. The district has an extensive educational program in water conservation and offers free pumping plant efficiency testing. (See also W91-07800) (Geiger-PTT)
W91-07801

PRELIMINARY GEOCHEMICAL AND THERMODYNAMIC ASSESSMENT OF THE GEOTHERMAL RESOURCES, SULPHUR SPRINGS AREA, ST. LUCIA, W.I.
Consiglio Nazionale delle Ricerche, Pisa (Italy). Ist. Internazionale per le Ricerche Geotermiche.
For primary bibliographic entry see Field 2F.
W91-07831

NEW ESU-20 EJECTOR GROUNDWATER-LOWERING UNIT.
For primary bibliographic entry see Field 8C.
W91-07882

GROUNDWATER IN BEKASI DISTRICT, WEST JAVA, INDONESIA.
Iwaco B.V., Rotterdam (Netherlands).
F. J. H. Dirks, D. Rismianto, and G. J. de Wit.
IN: Proceedings of 10th Salt-Water Intrusion Meeting. Geologisch Instituut R.U.G. (S 8), Ghent. 1989. p 47-55, 6 fig, 1 tab, 6 ref.

Descriptors: *Groundwater management, *Groundwater resources, *Indonesia, *Saline water intrusion, Coastal aquifers, Drinking water, Geohydrology, Groundwater mining, Groundwater potential, Hydrologic maps, Natural recharge, Saline-freshwater interfaces.

The project 'Groundwater Resources Survey in West Java' was designed to make an inventory of groundwater resources available for drinking water supply. In two districts within the West Java Province detailed hydrogeological mapping was carried out to assess the availability of fresh groundwater. The groundwater system in the Bekasi district, situated east of Jakarta in the northern coastal plain on the island of Java and on the east side of the Jakarta artesian basin, appeared to be very complex. Salinization of wells and decline in artesian heads or well yields have caused wide public concern and consequently underlined the need for proper groundwater management. One of the objectives of this project was the production of a groundwater potential map for this district. Using a variety of existing data, in combination with the results of the field survey, a better understanding of the groundwater systems in the coastal plain was achieved. It appeared that in the northern coastal plain, groundwater is usually recovered from thin sandy layers or sheets of limited extent which are imbedded in clayey, fine-grained sediments. Salinization of wells and the lowering of groundwater heads both occur on a local scale. The salinization process is mainly attributed to extruding connate seawater from the clayey layers. Lateral seawater intrusion may be of importance only in a narrow belt near the freshwater-saltwater interface. In general, the regional groundwater system in this area is a complex of many small, local, isolated aquifers. A schematization into extensive water-bearing aquifers separated by semi-pervious layers does not hold. Only within a very limited range bore logs can be correlated. Natural recharge, widely assumed to originate from the nearby mountains, is limited to the southern part of the coastal plain. Therefore, groundwater mining and its adverse effects may become important items in future groundwater management. (See also W91-07947) (Author's abstract)
W91-07950

HYDROGEOLOGICAL SITUATION AND GROUNDWATER MONITORING IN THE AREA OF THE 'DOLLART PORT PROJECT' IN LOWER SAXONY, FEDERAL REPUBLIC OF GERMANY.
Niedersaechsisches Landesamt fuer Bodenforschung, Hanover (Germany, F.R.)
For primary bibliographic entry see Field 2F.
W91-07952

ORIGIN AND AGE OF COASTAL GROUNDWATERS IN NORTHERN OMAN.
Paris-11 Univ., Orsay (France). Lab. d'Hydrologie et de Geochemie Isotopique.
For primary bibliographic entry see Field 5B.
W91-07953

NUMERICAL MODELS IN DESIGNING TUBE-WELL IRRIGATION AND DRAINAGE OF AN AQUIFER WITH A FRESH/SALT INTERFACE.
Euroconsult, Arnhem (Netherlands).
W. K. Boehmer, and W. Muhlenbruch.
IN: Proceedings of 10th Salt-Water Intrusion Meeting. Geologisch Instituut R.U.G. (S 8), Ghent. 1989. p 117-131, 10 fig, 1 tab, 7 ref.

Descriptors: *Groundwater management, *Groundwater quality, *Horizontal wells, *Irrigation design, *Model studies, *Numerical models, *Pakistan, *Saline-freshwater interfaces, Drainage programs, Drainage wells, Irrigation canals, Irrigation engineering, Saline groundwater, Saline water intrusion, Upconing, Well fields, Well pumping.

Irrigation in the Indus basin of Pakistan using river water and seepage from irrigation canals currently causes severe problems of water logging and salinity. Groundwater is being abstracted by more than 600 deep tube wells to lower the water table. This has resulted, however, in fast deterioration of the groundwater quality due to upconing of the saline/freshwater interface to within filter depth of the tube wells. A model study was carried out to optimize the abstraction of groundwater in order to meet the drainage requirements and the greater demand for irrigation water, while maintaining an acceptable quality of fresh groundwater for irrigation. The study was carried out with two numerical models. First the drainable surplus and its division over the irrigation area under historical and future irrigation regimes was determined using a one-layer finite difference model, calibrated using historical series of water-level and water-balance data. In a second study the Badon groundwater model was used to determine the effect of pumping on the saline/freshwater interface and to find an optimum division of the drainable surplus between skimming wells pumping freshwater and deep wells pumping saline water for drainage. The model was built up using the calibrated aquifer characteristics, water-level and water-balance data of the first model study, and was calibrated using data on water quality from different times and a map of the interface derived from well data and a geo-electrical survey. It proved possible to reproduce quality and interface data properly after the calibration process. The second model led to a new well field design. This design includes the installation of more high-capacity drainage wells in the saline-groundwater zone, no pumping in the transition zone between fresh and saline groundwater, reduced pumping by shallow, low-capacity skimming wells in the area with a shallow fresh-groundwater zone, and increased pumping and export of water through the irrigation canals in the northern part of the area with a deep freshwater zone and high seepage rates from the canals. (See also W91-07947) (Author's abstract)
W91-07957

SALT-WATER INTRUSION CONTROL WITH ELECTRIC BARRIERS.
Cagliari Univ. (Italy). Cattedra di Geologia Applicata.
For primary bibliographic entry see Field 2F.
W91-07967

HYDRAULIC MANAGEMENT APPROACH FOR SALT-WATER INTRUSION USING TWO-LEVEL PUMPING MECHANISM.
Soil and Water Research Inst., Giza (Egypt).
For primary bibliographic entry see Field 2F.
W91-07968

HYDROGEOLOGICAL SWIM-EXCURSION TO THE WESTERN COASTAL PLAIN OF BELGIUM.
Ghent Rijksuniversiteit (Belgium). Lab. for Applied Geology and Hydrogeology.
For primary bibliographic entry see Field 2F.
W91-07980

HYDROGEOLOGICAL SWIM-EXCURSION TO THE BLACK-SLUICE POLDER AREA IN THE FLEMISH VALLEY OF BELGIUM.
Ghent Rijksuniversiteit (Belgium). Lab. for Applied Geology and Hydrogeology.
For primary bibliographic entry see Field 2F.
W91-07981

4C. Effects On Water Of Man's Non-Water Activities

IMPACT OF RESIDENTIAL URBAN AREAS ON GROUNDWATER QUALITY: SWAN COASTAL PLAIN, WESTERN AUSTRALIA.
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
R. G. Gerritse, C. Barber, and J. A. Adeney.
CSIRO Water Resources Series No. 3, 1990. 26p, 5 fig, 15 tab, 74 ref, 2 append.

Descriptors: *Australia, *Environmental effects, *Groundwater quality, *Swan Coastal Plain, *Urbanization, *Water pollution sources, Boron compounds, Coastal aquifers, Nitrates, Salinity, Volatile organic compounds, Water resources development.

The effect of urbanization on a wide range of parameters for groundwater quality was investigated along a north-south transect on Bassendean Sands in Perth, Western Australia. Groundwater was sampled from both recently developed and well established sewered and unsewered urban residential areas. Results compared with those from studies on the quality of groundwater in urban residential areas in Perth on Spearwood Sands. Concentrations of all major ions in groundwater (e.g., total dissolved solids) increase with the intensity of development in urban areas. Salts of chloride and sulfate account for most of this increase; the proportion of sulfate increases strongly in groundwater from unsewered urban areas. Levels of nutrients (phosphates, nitrates) and other potential contaminants in the unconfined aquifer of the

Bassendean Sand system are low. Data show that this is a consequence of significant adsorption and, in the case of nitrate, bacterial denitrification. Conditions in the unconfined aquifer are well suited for denitrification (high natural total organic carbon, Eh=100-300 mV, pH=5-7) and bacterial activity was significant in all samples of the groundwater. Most compounds that are adsorbed and persist in the unsaturated zone of the soil will eventually reach groundwater, as has happened with borate in unsewered areas. (Lantz-PTT)
W91-07224

HYDROLOGIC AND GEOCHEMICAL CHARACTERIZATION OF RECHARGE AND GROUNDWATER FLOW IN A RECLAIMED-COAL-MINED LAND, NORTHWESTERN COLORADO.
Geological Survey, Denver, CO.
For primary bibliographic entry see Field 2F.
W91-07242

AREAL VARIATION OF SUSPENDED-SEDIMENT YIELDS WITHIN AND ADJACENT TO THE COAL FIELDS OF THE EASTERN COAL PROVINCE AND THE EASTERN REGION OF THE INTERIOR COAL PROVINCE.
For primary bibliographic entry see Field 2J.
W91-07251

PLANT BIOMASS AND NUTRIENT FLUX IN A MANAGED MANGROVE FOREST IN MALAYSIA.
University of Science, Penang (Malaysia). School of Biological Sciences.
For primary bibliographic entry see Field 2L.
W91-07309

RECENT LAND USE CHANGE.
Saint David's Univ. Coll., Lampeter (Wales). Dept. of Geography.
For primary bibliographic entry see Field 5C.
W91-07477

ACIDIFIED WELSH LAKES: THE SIGNIFICANCE OF LAND USE AND MANAGEMENT.
University Coll., London (England). Palaeoecology Research Unit.
For primary bibliographic entry see Field 5C.
W91-07478

INFLUENCE OF LAND MANAGEMENT ON STREAM WATER CHEMISTRY.
NRA Welsh Region, Cardiff.
For primary bibliographic entry see Field 5B.
W91-07487

AMELIORATION OF SURFACE WATER ACIDITY BY CATCHMENT MANAGEMENT.
Institute of Terrestrial Ecology, Grange-over-Sands (England). Merlewood Research Station.
For primary bibliographic entry see Field 5G.
W91-07491

ECOLOGICAL IMPACT OF URBAN STORMWATER RUNOFF STUDIED IN EXPERIMENTAL FLUMES: POPULATION LOSS BY DRIFT AND AVAILABILITY OF REFUGIAL SPACE.
Gesamthochschule Kassel (Germany, F.R.). Fachgebiet Siedlungswasserwirtschaft.
For primary bibliographic entry see Field 5C.
W91-07552

FISHES OF CRUTCHO CREEK AND THE NORTH CANADIAN RIVER IN CENTRAL OKLAHOMA: EFFECTS OF URBANIZATION.
Oklahoma Univ., Kingston. Biological Station.
W. J. Matthews, and F. P. Gelwick.
Southwestern Naturalist SWNAAB, Vol. 35, No. 4, p 403-410, December 1990. 3 fig, 1 tab, 15 ref, append.

Descriptors: *Fish, *Fish populations, *Oklahoma, *Stream biota, *Surveys, *Urban areas, *Urbanization, *Water quality, Canadian River, Crutcho Creek, Life history studies, Species composition, Species diversity, Water pollution effects, Watersheds.

In the spring and summer of 1987, 12 fish collections were made at four sites in the watershed of Crutcho Creek, a heavily urbanized stream within the Oklahoma City metropolitan area, and eight collections at four sites on the North Canadian River in and near Oklahoma City. Seventeen species were collected from the creek sites, and 30 species from the river sites. The fauna in these areas included most of the species typical of streams throughout central Oklahoma. Life stages from young-of-year to reproductive adults were present for numerous species. Despite the urbanization of the area, these streams have a viable and relatively diverse native fish fauna similar in species richness and composition to fish assemblages in similar-sized rural streams elsewhere in central Oklahoma. (Author's abstract)
W91-07576

RESEARCH NEEDS AND APPLICATIONS TO REDUCE EROSION AND SEDIMENTATION IN TROPICAL STEEPLANDS.
For primary bibliographic entry see Field 4D.
W91-07713

SOIL AND WATER LOSSES ON PLOTS WITH DIFFERENT LAND USE IN THE PHU WIANG WATERSHED.
Integrated Development of the Phu Wiang Watershed Project Khon Kaen (Thailand).
For primary bibliographic entry see Field 2J.
W91-07718

EFFECT OF BURNING AND REFORESTATION ON GRASSLAND WATERSHEDS IN THE PHILIPPINES.
Ecosystems Research and Development Bureau, College (Philippines).
For primary bibliographic entry see Field 2J.
W91-07719

STREAM SUSPENDED SEDIMENT LOAD AFTER CLEAR-FELLING AND DIFFERENT FORESTRY TREATMENTS IN TROPICAL RAINFOREST, SABAH, MALAYSIA.
Sveriges Lantbruksuniversitet, Umea. Dept. of Forest Site Research.
For primary bibliographic entry see Field 2J.
W91-07720

SOIL EROSION IN DRY-HOT VALLEYS OF TROPICS AND SUBTROPICS IN SOUTHWEST CHINA.
For primary bibliographic entry see Field 2J.
W91-07721

IMPACT OF COMMERCIAL LOGGING ON A SMALL RAINFOREST CATCHMENT IN ULU SEGAMA, SABAH, MALAYSIA.
Manchester Univ. (England).
For primary bibliographic entry see Field 2J.
W91-07730

ACCELERATED EROSION DUE TO CLEAR-CUTTING OF PLANTATION FOREST AND SUBSEQUENT TAUNGYA CULTIVATION IN UPLAND WEST-JAVA, INDONESIA.
Vrije Univ., Amsterdam (Netherlands). Inst. voor Aardwetenschappen.
C. A. Bons.
IN: Research Needs and Applications to Reduce Erosion and Sedimentation in Tropical Steeplands. IAHS Publication No. 192. International Association of Hydrological Sciences, Washington, DC. 1990. p 279-288. 4 fig, 10 ref.

Descriptors: *Agriculture, *Clear-cutting, *Erosion, *Forests, *Indonesia, *Java, *Land use, *Soil erosion, Bed load, Cultivation, Gullies, Gully erosion, Intercropping, Logging, Plant growth, Suspended sediments, Vegetation.

The effect of clearcutting and intensified Taungya (agricultural intercropping) cultivation on erosion rates was evaluated in a paired catchment study. Basin outputs of suspended sediment and bed load were compared to surface erosion rates from field and gully plot results for the phases of mature pine forest, forest clearance, temporary regeneration of the understory and Taungya cultivation. Sediment outputs were low (1.7 tons/ha) when the basins were covered with forest or scrub. No surface erosion was observed from logging, because the surface remained covered with logging debris and because the undergrowth quickly recovered from the manually executed operation. Two increases in both bed load and suspended sediment were observed at the basin outlet during Taungya cultivation. One increase, however, did not correspond with a similar increase in erosion from plots and could be identified as a delayed flushing of material trapped during forest clearance. The second Taungya related increase in sediment load was caused by incipient gullying of trails created by the farmers. The observed increase in basin sediment outputs during the Taungya cultivation can largely be explained by two processes: delayed flushing of material that was loosened from the stream bank during the logging operation, and the use of downslope field boundaries as paths where water flow concentrated and initiated gully formation. No increase in erosion was observed in the Taungya fields themselves. (See also W91-07713) (Brunone-PTT)
W91-07741

EFFECTS OF AGRICULTURE ON QUALITY OF WATER IN SURFICIAL SAND-PLAIN AQUIFERS IN DOUGLAS, KANDIYOHI, POPE, AND STEARNS COUNTIES, MINNESOTA.
Geological Survey, St. Paul, MN. Water Resources Div.
H. W. Anderson.
Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 87-4040, 1989. 52p, 15 fig, 9 tab, 19 ref.

Descriptors: *Agriculture, *Aquifers, *Environmental effects, *Groundwater quality, *Minnesota, *Nonpoint pollution sources, *Water pollution sources, *Water quality, Ammonia, Atrazine, Chlorides, Herbicides, Iron, Irrigation effects, Land use, Manganese, Nitrates, Seasonal variation, Sulfates.

The 245 water samples collected from 56 wells at 45 sites in surficial sand plain aquifers that underlie 600 sq mi of Douglas, Kandiyohi, Pope, and Stearns Counties in west-central Minnesota contained wide ranges in concentrations of some constituents--sulfate 2 to 160 mg/L, chloride 1.6 to 64 mg/L, nitrite plus nitrate nitrogen < 0.1 to 72 mg/L, ammonia < 0.01 to 3.3 mg/L, iron < 0.003 to 8.6 mg/L, and manganese < 0.001 to 1.5 mg/L. Substantial fluctuations in these constituents over time were observed. Nitrate concentrations exceeded the Minnesota drinking water standards of 10 mg/L (as N) in 50% of the wells sampled. Differences in concentrations of nitrate with depth below the water table were observed at 11 paired-well sites where one well was screened near the water table and another well was screened 10 or more ft below the water table. Similar differences in concentration with depth were observed in specific conductance, iron, chloride, and sulfate, but not as consistently. Nitrate concentrations fluctuated seasonally in response to the combined effects of precipitation and agricultural practices (irrigation and fertilization). Concentrations of sulfate, chloride, and, especially, nitrate were significantly higher in irrigated areas than in uncultivated areas. Mean nitrite plus nitrate nitrogen concentrations were 4.3 mg/L in uncultivated (natural) areas relatively unaffected by agriculture, 5.4 mg/L in non-irrigated cultivated areas, and 17 mg/L in irrigated cultivated areas. Four of eight wells sampled for herbicides in west-central Minnesota had detectable concentrations of the triazine herbicide atrazine that ranged from 0.2 to 0.6 microgm/L. (Lantz-PTT)
W91-07821

EFFECTS OF LIVESTOCK GRAZING ON RIPARIAN AND STREAM ECOSYSTEMS.
C. L. Armour, D. A. Duff, and W. Elmore.
Fisheries (Bethesda) FISHDN, Vol. 16, No. 1 p 7-11, January/February 1991. 29 ref.

Descriptors: *Environmental management, *Grazing, *Land management, *Land use, *Livestock, *Range management, *Riparian waters, *Stream banks, *Stream biota, Education, Environmental policy, Federal jurisdiction, Fish, Fish management, Fishing, Habitats, Public lands, Recreation, Research priorities, Riparian vegetation, Salmon, Sport fishing, Stream restoration, Monitoring, Streams, Trout.

A draft position paper on the effects of grazing on aquatic ecosystems was approved by the Executive Committee of the American Fisheries Society (AFS) on August 25, 1990. Fifty-two million acres of big game habitat, 100 million acres of small game and nongame habitat, and 19,000 miles of sport fishing streams have declined in quality as a result of land management practices, including overgrazing. The immediate effects of overgrazing are loss of streamside vegetation and trampling of streambanks, leading eventually to reduced populations or elimination of trout. Overgrazing is considered one of the principal factors contributing to the decline of native salmonids in the West. The resulting decrease in public recreational opportunities leads to heavier pressure on streams that are fished. The AFS advocates actions that will contribute to improved livestock management to improve and maintain habitat of streams on public lands. Objectives include restoring damaged streams to a productive fisheries status and protecting undamaged streams to prevent them from being lost to fisheries. Specific advocated actions include increasing grazing fees, inventorying and monitoring streams, and promoting public awareness and research. (Doria-PTT)
W91-07867

IRRIGATED FORESTRY IN ARID AND SEMI-ARID LANDS: A SYNTHESIS.
International Development Research Centre, Ottawa (Ontario).
For primary bibliographic entry see Field 3F.
W91-07905

SEASONAL AND WEATHER-RELATED CONTROLS ON SOLUTE CONCENTRATIONS AND ACID DRAINAGE FROM A PYRITIC COAL-REFUSE DEPOSIT IN SOUTHWESTERN INDIANA, U.S.A.
Indiana Univ. at Bloomington. Dept. of Geological Sciences.
For primary bibliographic entry see Field 5B.
W91-08040

4D. Watershed Protection

SEDIMENT MANAGEMENT WITH SUBMERGED VANES: I. THEORY.
Iowa Univ., Iowa City. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 8B.
W91-07588

SEDIMENT MANAGEMENT WITH SUBMERGED VANES: II. APPLICATIONS.
Iowa Univ., Iowa City. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 8B.
W91-07589

RESEARCH NEEDS AND APPLICATIONS TO REDUCE EROSION AND SEDIMENTATION IN TROPICAL STEEPLANDS.
Proceedings of an International Symposium held at Suva, Fiji, June 11-15, 1990. International Association of Hydrological Sciences, Washington, DC. 1990. 396p. Edited by R. R. Ziemer, C. L. O'Loughlin and L. S. Hamilton.

Descriptors: *Deforestation, *Erosion, *Erosion control, *Pacific Rim, *Sedimentation, *Soil erosion, *Tropical regions, Climatic zones, Forest management, Land use, Productivity, Research priorities, Temperate zone.

The Pacific Rim includes areas in all climatic zones, but most of the research and experience related to erosion and sedimentation in steepland areas is concentrated in the temperate regions of the world. World-wide interest has recently been focussed on tropical deforestation. Over five million hectares of tropical forests are cleared every year. Although not all forest conversions are environmentally harmful, the rapid large-scale removal of forests and their replacement with other types of land uses can have serious erosion and sedimentation consequences that can significantly degrade the long-term productivity of the land and waterways. Due to an urgent need for expanded erosion and sedimentation research in the tropics, and assessment of the transferability of research methods and results developed in temperate regions, and an introduction of practical methods of evaluating and reducing erosion and sedimentation in the tropics was conducted. (See W91-07714 thru W91-07751) (Brunone-PTT)
W91-07713

RESEARCH NEEDS AND APPLICATIONS TO REDUCE EROSION AND SEDIMENTATION IN THE TROPICS.
Hawaii Univ., Honolulu.
S. A. El-Swaify.
IN: Research Needs and Applications to Reduce Erosion and Sedimentation in Tropical Steeplands. IAHS Publication No. 192. International Association of Hydrological Sciences, Washington, DC. 1990. p 3-13. 1 fig, 3 tab, 19 ref.

Descriptors: *Erosion, *Erosion control, *Research priorities, *Sedimentation, *Soil erosion, *Tropical regions, Climates, Forest management, Land use, Mathematical models, Model studies, Prediction, Range management, Sediment transport, Temperate zone.

Understanding and quantifying the factors, processes, forms and consequences of erosion is necessary for predicting its potential magnitude, determining on-site and off-site impacts, and devising preventative or corrective measures. More information on these aspects has been derived for surface erosion, croplands and temperate environments than for concentrated or mass erosion, forest or range lands, or tropical environments. In these environments, the application of empirical models has dominated erosion prediction applications. Process-based models and quantitative means of relating soil loss to sediment delivery have received little attention. Decision aids which incorporate technological innovations and socio-economic political elements are needed to facilitate the implementation of erosion-reducing and sedimentation-reducing measures in tropical countries. Despite the wealth of information available on the factors and processes leading to erosion, sediment delivery and sedimentation, considerable doubt exists on the transferability of such information to the tropics. Empirical prediction and control models are restricted by site-specificity and the inapplicability of parameter values to prevailing climate, slope steepness and land use systems. (See also W91-07713) (Brunone-PTT)
W91-07714

SOIL EROSION IN DRY-HOT VALLEYS OF TROPICS AND SUBTROPICS IN SOUTHWEST CHINA.
For primary bibliographic entry see Field 2J.
W91-07721

SOIL EROSION AND SUSPENDED SEDIMENT PRODUCTION IN HONG KONG: DEVELOPMENT OF AN ASSESSMENT STRATEGY.
Hong Kong Univ. Dept. of Geography and Geology.
For primary bibliographic entry see Field 2J.
W91-07722

PRELIMINARY RESULTS OF THE RRAM PROJECT SOIL LOSS AND EROSION CONTROL TRIALS, RWANDA, 1987-1988.
Tropical Research and Development, Inc., Gainesville, FL.
For primary bibliographic entry see Field 2J.
W91-07723

CONSTRUCTION OF SEDIMENT BUDGETS TO ASSESS EROSION IN SHINYANGA REGION, TANZANIA.
Forest Service, Arcadia, CA.
L. M. Reid.
IN: Research Needs and Applications to Reduce Erosion and Sedimentation in Tropical Steeplands. IAHS Publication No. 192. International Association of Hydrological Sciences, Washington, DC. 1990. p 105-114. 1 fig, 2 tab, 15 ref.

Descriptors: *Agricultural watersheds, *Erosion, *Sediment yield, *Soil erosion, *Tanzania, Aerial photography, Economic aspects, Gully erosion, Range management, Seasonal variation, Sediment budget, Sheetwash, Spatial distribution, Topsoil, Universal soil loss equation, Wind erosion.

Sediment budgeting allows for analysis of erosion rates quickly and economically. A sediment budget was constructed, based upon the erosion process distribution, the relative contributions of land use activities, and the relative severity of relevant impacts. Observations during aerial surveys allowed for the construction of a flow chart, showing the types of erosion processes present and their interrelationships. End-of-dry-season aerial photographs showed extensive bare ground in the south, suggesting widespread sheetwash and wind erosion. Streambank erosion was locally common in the south and occasionally observed in the north. Field assessments were conducted to: (a) define the frequency of sheetwash and wind erosion; (b) determine sheetwash and wind erosion rates on rangelands; (c) determine rates of sheetwash and wind erosion on active and fallow croplands; and (d) measure parameters used in the Universal Soil Loss Equation, the Soil Loss Estimation Method for southern Africa, and the Wind Erosion Equation. Rates of gullying, sheetwash, and wind erosion varied throughout the area and produced differing impacts. Intense grazing causes the most widespread impact, while erosion due to imported cultivation methods is rapidly depleting farmable topsoils. In Shinyanga, the erosion problem is rooted in socio-economic concerns, such as the replacement of the indigenous agricultural practices by ones developed in temperate climes. A simple solution is the decreasing of grazing intensity and a reversion to more traditional tillage practices, but this solution is improbable in the modern economic and political context of the Shinyanga region. A long-term solution requires a solution to economic problems of day-to-day survival. (See also W91-07713) (Brunone-PTT)
W91-07724

RUNOFF PLOTS AND EROSION PHENOMENA ON TROPICAL STEEPLANDS.
Colorado State Univ., Fort Collins.
For primary bibliographic entry see Field 2J.
W91-07729

MONETIZING EROSION AND SEDIMENTATION COSTS WHERE STEEPLANDS MEET THE SEA.
East-West Environment and Policy Inst., Honolulu, HI.
For primary bibliographic entry see Field 6F.
W91-07733

SOIL CONSERVATION ORIENTED LAND SUITABILITY FOR TROPICAL ENVIRONMENTS.
DHV Consultants Ltd., Djakarta (Indonesia).
K. P. Kucera.
IN: Research Needs and Applications to Reduce Erosion and Sedimentation in Tropical Steeplands. IAHS Publication No. 192. International Association of Hydrological Sciences, Washington, DC.

1990. p 208-220. 2 fig, 3 tab, 8 ref.

Descriptors: *Conservation, *Erosion, *Erosion control, *Indonesia, *Land management, *Land use, *Soil erosion, *Soil management, *Tropic zone, Environmental impact, Soil classification, Soil texture.

Among the major requirements of land use planning and soil conservation is the development of a methodology which would suit the task of producing a soil conservation oriented land suitability classification that reflect soil conservation treatments in delineated land units. Soil conservation oriented land suitability refers to the assessment of recommended optimal land uses and recommended conservation treatments based on an empirically designed matrix including soil texture, soil depth, dominant slope and relative erodibility for evaluation of actual erosion hazard. In the Kali Konto Project in Indonesia, a soil conservation-oriented land suitability system has been developed which includes quantifiable levels of relative soil erodibility, soil depth, soil texture and slope ranges in order to classify various areas according to the most applicable land utilizations and soil conservation methods. Inherent erodibility indicates relative susceptibility to erosion of soil and related surficial geologic materials. Inherent erodibility of a soil material is assessed by identification either of features that dictate the rate at which erosion occurs, or the features that best reflect the actual erosive activity. (See also W91-07713) (Author's abstract)
W91-07734

SOIL EROSION IN EAST KALIMANTAN, INDONESIA.
Mulawarman Univ., Samarinda (Indonesia). Faculty of Forestry.
For primary bibliographic entry see Field 2J.
W91-07735

TRADITIONAL ADAPTATION TO NATURAL PROCESSES OF EROSION AND SEDIMENTATION ON YAP ISLAND.
Forest Service, Yap, Carolina Islands, TT.
For primary bibliographic entry see Field 2J.
W91-07736

ASSESSMENT OF LANDSLIDE PROBLEMS AND WATERSHED MANAGEMENT IN TAIWAN.
Council for Agricultural Planning and Development, Taipei (Taiwan). Conservation Div.
S. W. Lee, J. D. Cheng, C. W. Ho, Y. C. Chiang, and H. H. Chen.
IN: Research Needs and Applications to Reduce Erosion and Sedimentation in Tropical Steeplands. IAHS Publication No. 192. International Association of Hydrological Sciences, Washington, DC. 1990. p 238-246. 2 tab, 5 ref.

Descriptors: *Erosion control, *Landslides, *Rainfall intensity, *Resources management, *Sedimentation, *Soil erosion, *Taiwan, *Watershed management, Flooding, Land use, Regulations, Research priorities, Sediment load, Siltation, Slopes, Stream erosion, Typhoons.

During heavy rainfall in the May to October typhoon season, streams on Taiwan often carry tremendous sediment loads, originating mostly from landslides and streambank erosion. These high sediment loads aggrade the stream channels and silt up reservoirs downstream. Thus, since the early 1950s, landslide and sediment control has been the dominant component of Taiwan's watershed management strategy which normally also includes forest management, soil conservation on cultivated hillslopes, and land use regulation. During the past four decades, watershed management has enjoyed increasing public and government support mainly due to the frequent flooding during the typhoon season. Watershed management projects have contributed significantly to the national goals of environmental protection and disaster prevention by enhancing slopeland stability, reducing the severity of damages associated with many sediment-laden flood waters. Present day watershed management requires new vision and initiatives to meet the rising needs and expectations of the people. (See also W91-07713) (Author's abstract)
W91-07737

ECONOMICS OF SOIL CONSERVATION: THE CASE STUDY OF THE FIJI GINGER INDUSTRY.
Ministry of Primary Industries, Suva (Fiji).
N. V. Buresova, and A. M. McGregor.
IN: Research Needs and Applications to Reduce Erosion and Sedimentation in Tropical Steeplands. IAHS Publication No. 192. International Association of Hydrological Sciences, Washington, DC. 1990. p 247-255. 3 fig, 12 ref.

Descriptors: *Agricultural engineering, *Conservation, *Economic aspects, *Erosion control, *Farm management, *Fiji, *Ginger, *Soil management, Contour terracing, Education, Legislation, Regulations, Topography, Waterlogging.

Ginger is one of Fiji's major agricultural industries. Ginger thrives in a high temperature and high rainfall environment, but demands well-drained soil. Farmers tend to prefer steep land to avoid waterlogging. Severe land degradation now threatens the production base of the industry. Despite the financial benefits from the adoption of simple soil conservation measures, such as contour planting, contour drains, or veviter grass strips, farmers have shown little interest in the investment. To reverse this situation, a combination of measures, including legislation, fiscal incentives, and information dissemination is proposed. The ginger growing area should be declared a Conservation Area under the Land Conservation and Improvement Act; subsidies should be paid to farmers who practice good soil husbandry; and, demonstration farm should be established on typical topography to allow for training and education programs. (See also W91-07713) (Brunone-PTT)
W91-07738

PREDICTION AND PREVENTION OF FOREST LANDING FAILURES IN HIGH-INTENSITY RAINFALL AREAS OF NORTHERN NEW ZEALAND.
Forest Research Inst., Christchurch (New Zealand).
R. J. Coker, A. J. Pearce, and B. D. Fahey.
IN: Research Needs and Applications to Reduce Erosion and Sedimentation in Tropical Steeplands. IAHS Publication No. 192. International Association of Hydrological Sciences, Washington, DC. 1990. p 311-317. 1 fig, 10 ref.

Descriptors: *Earthworks, *Erosion, *Erosion control, *Forests, *Landings, *New Zealand, *Rainfall intensity, *Storm runoff, Construction, Drainage, Resource management, Sedimentation, Slopes, Soil erosion.

The interaction of high-intensity rainstorms with landings and other earthworks necessary for harvesting exotic forests in steepland areas in northern New Zealand has led to severe localized erosion. Care in planning landing location and construction may contribute to the reduction of sedimentation and mass failure in forest plantations. Earthworks related to forest harvesting operations can, under high intensity rainfall, suffer severe erosion, sometimes several years after harvesting has been completed. Downstream impacts of these failures include: loss of young restocked forest in debris flow channels, loss of landing area, and positions for future guyline anchors, and damage to adjacent land. Essential components of construction are full benching of fill slopes to reduce the effective depth of fill, end-hauling if necessary, and removal of large woody debris before fill is deposited. Post-harvesting management recommended involves attention to drainage (which should be directed away from fill), reduction of woody overburden (by burning if necessary), and restocking at least the potentially productive, unconsolidated fill slopes. (See also W91-07713) (Brunone-PTT)
W91-07744

PLANNING SECONDARY ROADS TO REDUCE EROSION AND SEDIMENTATION IN HUMID TROPIC STEEPLANDS.
Oregon State Univ., Corvallis. Dept. of Forest Engineering.
P. W. Adams, and C. W. Andrus.
IN: Research Needs and Applications to Reduce Erosion and Sedimentation in Tropical Steeplands. IAHS Publication No. 192. International Association of Hydrological Sciences, Washington, DC. 1990. p 318-327. 1 tab, 41 ref.

Descriptors: *Erosion control, *Humid climates, *Road construction, *Sedimentation, *Soil erosion, *Tropical areas, Economic aspects, Logging, Physical aspects, Planning, Rainfall intensity, Slopes.

Secondary roads can be a major source of soil and water problems in the humid tropics in steep terrain. Careful planning can reduce these problems, but vital supportive experience must often be extrapolated from other locations, including temperate regions. Of particular concern are rainfall intensities and peak streamflows, which may be over ten times greater in the tropics than in temperate regions, and the need for economical approaches. Heavy traffic, even during periods of dry weather, can increase rates of erosion and sedimentation from secondary roads. Controlling erosion and other problems from secondary roads should begin with planning to construct no more roads than are absolutely necessary. Road spacings and locations must accommodate the physical and economic limits of the timber harvest systems that will be used. In steep terrain, stream valleys offer a convenient and relatively inexpensive route for roads. If roads must be routed near stream bottoms, it is especially important to keep them above flood levels and to retain a strip of undisturbed vegetation between roads and larger streams. This buffer strip can help filter any eroded soil and prevent disturbance to the stream bed and banks. Swamps, springs, and other wet spots should be avoided. The number of stream crossings should be kept to a minimum and placed at right angles to the stream to reduce channel and bank disturbance. Methods to control erosion associated with secondary roads include wide road spacings, ridgetop locations, buffer strips, rolling dips, low water fords, timber bridges, and selective surfacing and stabilization with native materials. (See also W91-07713) (Brunone-PTT)
W91-07745

SELECTION OF RIPARIAN BUFFER ZONES IN HUMID TROPICAL STEEPLANDS.
Institute of Tropical Forestry, Rio Piedras, PR.
P. N. Scatena.
IN: Research Needs and Applications to Reduce Erosion and Sedimentation in Tropical Steeplands. IAHS Publication No. 192. International Association of Hydrological Sciences, Washington, DC. 1990. p 328-337. 1 fig, 4 tab, 18 ref.

Descriptors: *Buffer zones, *Environmental protection, *Erosion control, *Forestry, *Humid climates, *Riparian land, *Sediment control, *Slope protection, *Tropical areas, Economic aspects, Resource management, Sediment transport, Storm runoff, Stream channels, Vegetation.

The use of riparian protection zones in forestry operations is based on the premise that the structure of the riparian zone has a controlling influence on the environmental conditions of the aquatic habitat. In the design of riparian protection zones, maximized environmental benefits can be met by minimizing changes in light, temperature, sediment and channel morphology within the riparian zone; and reducing offside exports of sediment and nutrients by providing storage sites adjacent to the stream channel. The determination of effective buffer width and extent has typically been established by establishing and protecting the minimum area contributing the runoff, and by determining the sediment trapping efficiency of the vegetative strip. Both the watershed area and commercial basal areal area increases geometrically as smaller and smaller channels are protected. Due to the relatively high stream channel densities in tropical

steeplands, protection of intermittent channels is economically prohibitive. Furthermore, since storm runoff is dominated by channelized flow from intermittent swales, and the steep channel margins cannot store large volumes of sediment, the sediment trapping efficiency of these buffers is greatly reduced. Delimiting buffers on the presence of herbaceous vegetation provides both a practical and ecologically sound solution to buffer selection. Since herbaceous layers are a diagnostic feature of these riparian zones, buffers based on their presence should reduce changes to ecological characteristics of the system. (See also W91-07713) (Brunone-PTT)
W91-07746

AGROFORESTRY SYSTEMS TO CONTROL EROSION ON ARABLE TROPICAL STEEPLANDS.
Ohio State Univ., Columbus.
R. Lal.
IN: Research Needs and Applications to Reduce Erosion and Sedimentation in Tropical Steeplands. IAHS Publication No. 192. International Association of Hydrological Sciences, Washington, DC. 1990. p 338-346. 1 fig, 7 tab, 17 ref.

Descriptors: *Agriculture, *Agroforestry, *Erosion, *Erosion control, *Forestry, *Forests, Conservation, Crop production, Gully erosion, Overland flow, Rainfall intensity, Rill erosion, Slopes, Soil management.

Steeplands are extensively used for food crop production in many regions of Asia, South America and Central America and Africa. However, sustainability of these fragile resources is being rapidly undermined by accelerated runoff and soil erosion. Predominant erosion processes in tropical steeplands are rill and gully erosion. Soil erosion is related to rainfall intensity, velocity of overland flow, and soil characteristics. Risks of soil erosion can be minimized through biological techniques of erosion prevention and/or engineering techniques of erosion control. Agroforestry is a special case of mixed cropping, whereby food crop annuals and animals are raised in association with trees, shrubs and woody perennials. Agroforestry decreases runoff and soil erosion by: (1) reducing runoff velocity by creating a barrier formed by the closely-spaced hedge of shrubs; (2) decreasing runoff amount by allowing more time for water to infiltrate into the soil; (3) minimizing raindrop impact and sheet erosion due to the protective ground cover provided by the shrub canopy and mulch available from leaf fall and prunings; and (4) curtailing sediment transport in overland flow especially if the sediment carrying capacity of water runoff is not filled. The usefulness of agroforestry in erosion control from tropical steeplands has been demonstrated in Java, Philippines, Kenya, Sumatra, and Nigeria. Agroforestry systems have a potential to develop sustainable management alternatives for intensive use of tropical steeplands for food crop applications. (See also W91-07713) (Author's abstract)
W91-07747

ECOLOGICAL RESTORATION OF LANDSLIDES IN MACAYA BIOSPHERE RESERVE, HAITI.
Florida Univ., Gainesville.
J. E. McBride, and R. L. Voss.
IN: Research Needs and Applications to Reduce Erosion and Sedimentation in Tropical Steeplands. IAHS Publication No. 192. International Association of Hydrological Sciences, Washington, DC. 1990. p 347-354. 10 ref.

Descriptors: *Agriculture, *Developing countries, *Erosion control, *Haiti, *Land reclamation, *Landslides, *Soil conservation, Economic aspects, Education, Slopes, Species composition, Succession.

A program of ecological restoration of landslides is being developed for agriculturally degraded areas of Macaya Biosphere Reserve, Haiti. Field implementation is based on a concurrent process of research and extension which identifies appropriate species and erosion-control practices readily adoptable by small farmers without access to financial incentives or developed infrastructure. Appropriate native species for reclamations are being identified by a floristic survey of natural successional vegetation on a chronosequence of landslides, and by experimental manipulations of soil nutrient limitations on the invasion and establishment of early and later successional species. Immediate field trials of nitrogen-fixing species on new landslides serve as demonstrations of steep-slope soil conservation and reclamation, supported by a program of local community education and extension. Species useful for fuelwood, timber, or forage are given priority in these areas of subsidence farming. (See also W91-07713) (Author's abstract)
W91-07748

STABILIZING HILLSIDE FARMING SYSTEMS IN THE SIERRA OF THE DOMINICAN REPUBLIC.
California Univ., Albany. Div. of Biological Control.
M. A. Altieri.
IN: Research Needs and Applications to Reduce Erosion and Sedimentation in Tropical Steeplands. IAHS Publication No. 192. International Association of Hydrological Sciences, Washington, DC. 1990. p 355-363. 8 fig, 1 tab, 4 ref.

Descriptors: *Dominican Republic, *Erosion, *Erosion control, *Runoff, *Soil conservation, *Soil erosion, Agriculture, Organic matter, Population density, Rainfall intensity, Resources management, Sediment yield, Slopes, Vegetation.

About 65% of the Dominican Republic land base corresponds to mountain areas concentrating approximately 30% of the total population. An important task of Plan Sierra is to determine the potential of the proposed systems to reduce soil degradation. In the Sierra, the main factors that push farmers to deforest are lack of access to land and the loss of soil fertility. Erosion in the Sierra includes rain erosivity, soil erodibility, land use and crop management, slope length and inclination as well as access to land and the degree of poverty of the rural population. Erosion in the Sierra can be represented in two phases: one phase related to rainfall intensity and volume, and the other related to sediment production resulting from the soil detachability according to the impact of raindrops and the level of runoff. Both phases are affected by the management of the conuco in relation to: vegetation cover which minimizes raindrop impact and runoff, soil conservation practices that shorten slope length and catch sediments, soil organic matter enrichment which increases water infiltration, and drainage practices that eliminate excess water. In most cases, measured erosion rates obeyed the determinant factors of slope, rainfall and soil cover; but non-detected differences in the soil profile could derive differential effects on soil erosion levels, even under similar conditions of slope, cover and management. Long term measurements of soil loss will continue at Plan Sierra in order to observe the consistency of the method, as well as to provide an idea of the sustainability of the proposed systems in terms of their continuous soil protection and stabilized yields. (See also W91-07713) (Brunone-PTT)
W91-07749

TERRACING RE-EXAMINED IN THE LIGHT OF RECENT FINDINGS IN NEPAL AND INDONESIA.
Gibsons, British Columbia, Canada.
B. Carson.
IN: Research Needs and Applications to Reduce Erosion and Sedimentation in Tropical Steeplands. IAHS Publication No. 192. International Association of Hydrological Sciences, Washington, DC. 1990. p 364-373. 2 fig, 2 tab, 3 ref.

Descriptors: *Erosion control, *Indonesia, *Nepal, *Soil erosion, *Terracing, *Tropical areas, Agriculture, Bench terraces, Economic aspects, Resources management, Slopes, Soil conservation.

Bench terracing is well documented as an excellent method to reduce soil erosion from steeply sloping agricultural land in the tropics. Soil conservation projects in both Indonesia and Nepal recommend construction of terraces as a corner stone to better upland management. Introduced bench terraces, however, often fail to be adopted or even maintained by local farmers. Factors affecting the suitability of fields for bench terracing include soil infiltration and permeability, slope, consistency of the soil, the presence of stones, soil depth and subsurface characteristics, and climatic conditions. In addition, socioeconomic aspects such as land tenure, economic status of the farmer, nature of the farming system, and profitability of the farming system must be considered. While terracing is often an excellent technique to enhance the productivity and sustainability of sloping agricultural land, a blanket policy of encouraging terrace construction is in itself unlikely to speed their adoption. While considerable scope exists for expansion of terracing in many parts of the world, conservationists should focus on the local physical and socioeconomic conditions to determine if and how terraces might improve local farming systems. (See also W91-07713) (Brunone-PTT)
W91-07750

WATERSHED RESTORATION REDUCES RUNOFF AND SEDIMENTATION FROM COMPARATIVE WATERSHEDS IN PAKISTAN'S SUBTROPICAL SCRUB ZONE.
Pakistan Forest Inst., Peshawar.
M. Hanif, F. Subhan, and W. F. Megahan.
IN: Research Needs and Applications to Reduce Erosion and Sedimentation in Tropical Steeplands. IAHS Publication No. 192. International Association of Hydrological Sciences, Washington, DC. 1990. p 374-382. 4 fig, 1 tab, 4 ref.

Descriptors: *Catchment areas, *Erosion control, *Pakistan, *Sedimentation, *Storm runoff, *Watershed restoration, *Watersheds, Erosion, Monsoons, Rainfall intensity, Runoff, Sediment yield, Statistical analysis, Storms, Subtropic zone.

Two comparative watersheds of 81 ha represented some of the most severe erosion problems in the subtropical scrub zone of northern Pakistan. A traditional treated-control watershed study was used to evaluate the effectiveness of a comprehensive watershed restoration effort during calibration and treatment measurement periods totalling 9 and 5 years, respectively. Watershed restoration included tree planting, channel erosion control structures, and grazing management. Evaluation of watershed restoration success was based on the summer monsoon season when high intensity rains cause severe runoff and erosion. Covariance analysis of 141 storms showed that restoration reduced storm runoff and sediment yields by 55% and 78%, respectively. Supporting information suggests that the benefits of the watershed restoration programs are even greater. The success of these watershed restoration practices demonstrates the potential for major improvements in the protection of Pakistan's vital irrigation system. (See also W91-07713) (Author's abstract)
W91-07751

CONSERVATION TILLAGE SYSTEMS.
Agricultural Research Service, Bushland, TX. Conservation and Production Research Lab.
For primary bibliographic entry see Field 3F.
W91-07755

POLICY AND PRACTICE IN THE MANAGEMENT OF TROPICAL WATERSHEDS.
For primary bibliographic entry see Field 6G.
W91-07907

IRRIGATION AND FLOOD/EROSION CONTROL AT HIGH ALTITUDES IN THE ANDES.
International Inst. for Land Reclamation and Improvement, Wageningen (Netherlands).
W. Van Immerzeel, and R. J. Oosterbaan.
Annual Report 1989. International Institute for Land Reclamation and Improvement, Wageningen, The Netherlands. 1989. p 8-24, 1 fig, 1 tab, 11 photos, 4 ref.

Descriptors: *Andes Mountains, *Bolivia, *Developing countries, *Erosion control, *Flood control, *Irrigation, *Peru, Alpine regions, Flooding, Social aspects, Surface water, Water resources management.

Irrigation and flood control practices at high altitudes in the Andes have quite distinct agroecological and socioeconomic requirements and characteristics compared with similar water management activities elsewhere. The potential for small-scale irrigation in the Andes of Peru and Bolivia is great, but it is only being partly exploited. The reasons for the limited use of the water resources are probably to be found in the precarious socioeconomic conditions of the mountain tribes (mainly the Quechua-speaking Indians) and the turbulent history of national policies toward their social, cultural, and economic development. Irrigation development projects, therefore, need much care and attention. The potential for small-scale flood control is not as great as for irrigation, because it is limited to the smaller pampas. Flood control, however, can be effective and inexpensive with the use of the widely available champas, and can provide a quick improvement of the natural pastures. Yet, like irrigation, the practice of flood control has not been developed to its full potential, probably owing to the same background conditions of the people. There is a great need for erosion control measures, because they will improve the fertility of the mountain slopes, will preserve water, and will mitigate downstream flooding. Different methods for erosion control include interception ditches (zanjas de infiltracion), short, steep terraces (terazas), and the traditional long terraces (andenes). (Lantz-PTT)
W91-07909

5. WATER QUALITY MANAGEMENT AND PROTECTION

5A. Identification Of Pollutants

USEPA MANUAL OF METHODS FOR VIROLOGY. CHAPTER 7, REVISED SEPTEMBER 1989.

Environmental Monitoring and Support Lab.-Cincinnati, OH.
Report No. EPA/600/4-84/013(R7), September 1989. 6 p, 4 fig, 16 ref.

Descriptors: *Laboratory methods, *Monitoring, *Pollutant identification, *Viruses, Analytical methods, Microbiological studies, Sediment analysis, Sludge, Soil analysis, Suspended solids.

A procedure that may be used to monitor for the presence of solids-associated viruses requires that the virus be eluted directly from solids. Samples which may have a portion of the virus content suspended unattached in a liquid matrix, such as in sludges and sediments, must first be treated to bind the free viruses to the solids. Initial steps in this procedure differ based on whether or not the solids are suspended in a liquid. Because of the naturally high association of viruses with solids, the virus content of the liquid matrix is likely to represent only a small fraction of the viruses present in the sample. The procedures outlined in this chapter require dispensing the entire sample volume into a centrifuge bottle. If bottles of sufficient capacity are unavailable, the sample should be divided and then recombined after centrifugation. Use of aseptic techniques and sterile materials and apparatus are required. All contaminated materials must be sterilized before discarding them. (Lantz-PTT)
W91-07208

MARINE AMOEBAE IN WATERS OF CHINCOTEAGUE BAY, VIRGINIA: ECOLOGICAL SIGNIFICANCE OF 'OLD' AND 'NEW' SPECIES.

Rescon Associates, Inc., Royal Oak, MD.
For primary bibliographic entry see Field 2L.
W91-07365

DETERMINATION OF NITRITE AND NITRATE IN VENICE LAGOON WATER BY ION INTERACTION REVERSED-PHASE LIQUID CHROMATOGRAPHY.

Turin Univ. (Italy). Dipt. di Chimica Analitica.
M. C. Gennaro, P. L. Bertolo, and A. Cordero.
Analytica Chimica Acta ACACAM, Vol. 239, No. 2, p 203-209, December 3, 1990. 6 fig, 2 tab, 20 ref.

Descriptors: *Analytical methods, *Chemical analysis, *Lagoons, *Liquid chromatography, *Nitrates, *Pollutant identification, *Venice, *Venice Lagoon, *Water analysis, Ammonia, Anions, Chemical interference, Chlorides, Chromatography, Comparison studies, Filtration, Nitrogen cycle, Nitrogen oxides, Reagents, Retention time, Sample preservation, Seawater.

Ion interaction reversed-phase liquid chromatography with octylammonium orthophosphate as the interacting reagent and a reversed-phase C18 column was applied to the identification and determination of nitrate and nitrite in Venice lagoon water. Interference by the high chloride content was systematically studied and the results obtained with different column packings were compared. With spectrophotometric detection at 230 nm, nitrite at 0.005 mg/L can be detected and determined even in the presence of 0.70 M chloride. The dependence of the retention time of nitrite on the chloride concentration was studied for two reversed-phase columns with different packings. Concentrations of 0.30 mg/L of nitrite and 0.20 mg/L of nitrate were found in Venice lagoon water. A clear advantage offered by the chromatographic technique proposed is that it does not require any pretreatment or derivatization of the sample as part of a suitable filtration process. This is particularly important when dealing with complex matrices such as seawater, where any pretreatment process could modify the speciation equilibria that are constantly taking place. (Doria-PTT)
W91-07368

SPECTROPHOTOMETRIC DETERMINATION OF URANIUM IN NATURAL WATERS.

Santiago Univ. (Spain). Faculty of Chemistry.
A. Bermejo-Barrera, M. C. Yebra-Biurrun, and L. M. Fraga-Trillo.
Analytica Chimica Acta ACACAM, Vol. 239, No. 2, p 321-323, December 3, 1990. 2 tab, 15 ref.

Descriptors: *Analytical methods, *Chemical analysis, *Pollutant identification, *Spectrophotometry, *Uranium, *Water analysis, Acidity, Bicarbonates, Calcium, Cations, Chemical interference, Drinking water, Fluorides, Ion exchange chromatography, Ions, Metal complexes, Potassium, Preconcentration, Reagents, Sodium, Sulfates.

A method for the spectrophotometric determination of uranium in samples of natural waters is described. Ion exchange with Amberlite IR-120 (H+) was used to concentrate the metal. The absorption properties of the complex formed between uranium and the chromogenic reagent Arsenazo III, its stability for several hours, the effect of the pH on the ability of the resin to retain uranium, the reproducibility of the method, and the effects of ionic interferences were considered. Na, K, Ca, sulfate, and fluoride ions had no effect on the accuracy of the assay for uranium:ion ratios of 1:83. The effect on the ability of the resin to retain uranium was investigated for 100 ml of a standard solution containing 6 micrograms of uranium at different pH levels. At pH 2.5, 4.6, 6.5, and 8.5, the recoveries were 97.78, 100.74, 94.81, and 93.33 percent, respectively; thus, pH 4.6 gave almost complete recovery. Water samples were taken from the municipal water supply of La Coruna (Spain) and various brands of bottled Galician water. The sensitivity was 0.67 and 0.05 micrograms/L of uranium for the direct and addition methods, respectively. Uranium concentrations for the samples analyzed were between 0.10 and 0.50 micrograms/L. (Doria-PTT)
W91-07369

DETERMINATION OF ALUMINUM SPECIATION IN ACID WATERS.

University Coll. of Swansea (Wales). Dept. of Chemical Engineering.
X. Goenaga, and D. J. A. Williams.
IN: Acid Waters in Wales. Monographiae Biologicae Volume 66. Kluwer Academic Publishers, Norwell, Massachusetts. 1990. p 189-201. 4 fig,3 tab, 31 ref.

Descriptors: *Acid rain effects, *Acidic water, *Acidification, *Aluminum, *Mathematical models, *Path of pollutants, *Wales, Analytical methods, Chemical properties, Physical properties, Suspended solids, Toxicity, Water chemistry, Watersheds.

The determination of the speciation of aluminum in acidified freshwaters is an important factor in the interpretation, prediction and possible modification of aluminum toxicity and mobilization in acidified catchments. A strategy for the determination of important aluminum fractions is identified, and particular attention is given to the development of a mathematical model for predicting the concentration of inorganic and organic monomeric aluminum species in equilibrium. The use of the speciation scheme is illustrated using freshwater samples from the Llyn Brianne catchment. Model predictions of organically complexed aluminum concentration are compared with experimental determinations. The high concentrations of suspended solids found in the streams during episodes may act as important sources or sinks of mobile aluminum, depending on the physico-chemical conditions and composition of the aqueous solution. Therefore, they may control to some extent the aluminum chemistry of these samples. The extent to which adsorbed aluminum is biologically available is unknown, but it is likely to be less active than inorganic monomeric aluminum. The mathematical model (SPECIAL) developed for thermodynamic equilibrium of aluminum in acid waters includes Al-HS interactions as well as inorganic reactions. This model can be used to predict the concentration of organically complexed aluminum, together with the concentration of inorganic monomeric aluminum species. Model predictions compare favorably with experimental determinations of organically complexed aluminum in samples from the Llyn Brianne catchment. It is envisaged that if its application is validated using a wider range of samples from various locations, model predictions can substitute the tedious and often error prone experimental determinations. (See also W91-07472) (Agostine-PTT)
W91-07484

EFFECT OF SOME POLLUTANTS ON SCE OF GRASS CARP (CTENOPHARYNGODON IDELLUS) CELLS (IN CHINESE).

Hangzhou Univ. (China).
For primary bibliographic entry see Field 5C.
W91-07533

CHLOROPLAST BIOASSAY FOR THE DETERMINATION OF HERBICIDES IN WATER--AN IMPROVED ELECTRON ACCEPTOR SYSTEM (CHLOROPLASTEN-BIOTEST ZUR HERBIZIDBESTIMMUNG IM WASSER--OPTIMIERUNG DES ELEKTRONENAKZEPTORSYSTEMS).

ESWE-Inst. fuer Wasserforschung und Wassertechnologie G.m.b.H., Wiesbaden (Germany, F.R.).
B. Hirschwald, G. M. Zimmermann, S. Normann, and K. Haberer.
Zeitschrift fuer Wasser- und Abwasser-Forschung ZWABAQ, Vol. 23, No. 5, p 184, October 1990, 7 ref. English summary.

Descriptors: *Analytical methods, *Bioassay, *Chloroplasts, *Electron transport, *Herbicides, *Pollutant identification, *Water analysis, Dichlorophenolindophenol, Inhibition, Oxygen, Photosynthesis, Potassium ferricyanide.

The inhibition by herbicides of the electron-transport chain in chloroplasts isolated from spinach is the basis for a proposed bioassay. The inhibited electron transport results in a reduction in oxygen production, which is a measure of the available

substrate. For oxygen production, chloroplasts need an electron acceptor to take up the electron which is made available by the dissociation of water. The combination of two artificial electron acceptors, potassium ferricyanide and 2,5-dichlorophenolindophenol (DCPIP), results in constant reaction conditions. When this combination of reagents is added simultaneously, the concentration of DCPIP is markedly lowered at first, yet the desired result is produced. Further investigations into the successful application of this test to herbicide determination will be reported elsewhere. (King-PTT)
W91-07542

ADDITIVITY OF BIOASSAY RESULTS IN WATER SAMPLES OF UNKNOWN COMPOSITION (DIE ADDITIVITAET DER RESULTATE VON BIOTESTS MIT WAESSERN UNBEKANNTER ZUSAMMENSETZUNG).
Ruhrverband, Essen (Germany, F.R.). Chemisches und Biologisches Lab.
P. Koppe.
Zeitschrift fuer Wasser- und Abwasser-Forschung ZWABAQ, Vol. 23, No. 5, p 185-189, October 1990, 2 fig, 12 ref. English summary.

Descriptors: *Bioassay, *Data interpretation, *Quantitative analysis, *Wastewater analysis, *Wastewater disposal, *Water quality, Effluent charges, Pollution effects, Reproducibility, Toxicity, Water pollution effects, Water sampling.

The determination of the noxiousness of sewage by bioassay is done quantitatively. The first requisite for a method of measuring natural processes is reproducibility. If the numeric results of bioassays are to be used further--e.g. for the calculation of pollution indices--the quantitative results must obey the law of additivity. Thus, a wastewater with a higher concentration of toxic substances must yield a numerically higher bioassay value than a wastewater with lower concentrations of the same substances. Dilution minimizes the interaction among the constituents of sewage and thus satisfies this requirement to a certain extent. In the levying of pollution charges, pollution units for fish toxicity (calculated as a product of the dilution factor and the wastewater volume) are additive values accounted for in turn. (King-PTT)
W91-07543

EVALUATION OF THE DYNAMIC DAPHNIA TEST--EFFECT OF PESTICIDES ON THE SWIMMING BEHAVIOR OF DAPHNIA MAGNA UNDER LABORATORY AND FIELD CONDITIONS (ERFAHRUNGEN MIT DEM DYNAMISCHEN DAPHNIENTEST--EINFLUSS VON PESTIZIDEN AUF DAS SCHWIMMVERHALTEN VON DAPHNIA MAGNA UNTER LABOR- UND PRAXISBEDINGUNGEN).
Landesanstalt fuer Umweltschutz Baden-Wuerttemberg, Karlsruhe (Germany, F.R.).
For primary bibliographic entry see Field 5C.
W91-07545

ANTIBIOTIC RESISTANCE INDEXING OF ESCHERICHIA COLI TO IDENTIFY SOURCES OF FECAL CONTAMINATION IN WATER.
Maryland Univ., College Park. Dept. of Microbiology.
For primary bibliographic entry see Field 5B.
W91-07564

STREAM FISHES ESTIMATE WATER QUALITY IN DAYTON-MONTGOMERY COUNTY PARK DISTRICT RESERVES.
Miami Univ.-Middletown, OH. Dept. of Zoology.
N. D. Mundahl, and C. T. Hockett.
Ohio Journal of Science OJSCA9, Vol. 90, No. 5, p 146-151, December 1990. 1 fig, 3 tab, 13 ref.

Descriptors: *Bioindicators, *Fish populations, *Ohio, *Stream biota, *Water pollution effects, Land use, Lotic environment, Species composition, Surveys, Wastewater facilities, Wastewater outfall.

Information on the fish communities within seven streams and rivers in or near the Dayton/Mongomery County (Ohio) Park District reserves were gathered in conjunction with compiling a fish species list for the Park District reserves and in order to calculate an Index of Biotic Integrity (IBI) based on the fish communities in each stream as an estimate of water quality. Fifty-two species of fishes were found in lotic habitats in or near the reserves, and more extensive sampling likely will reveal the presence of additional species. IBI scoring of the fish communities indicated that water quality within the reserves ranged from fair to exceptional. It would appear that improvements of water quality and fish communities within the reserves may require changes in wastewater treatment outfalls and stream drainage land-use practices. (Author's abstract)
W91-07571

MULTILABORATORY EVALUATION OF METHODS FOR DETECTING ENTERIC VIRUSES IN SOILS.
Environmental Protection Agency, Cincinnati, OH.
For primary bibliographic entry see Field 7B.
W91-07649

RAPID IMMUNOCAPTURE OF PSEUDOMONAS PUTIDA CELLS FROM LAKE WATER BY USING BACTERIAL FLAGELLA.
Freshwater Biological Association, Ambleside (England).
J. A. Morgan, C. Winstanley, R. W. Pickup, and J. R. Saunders.
Applied and Environmental Microbiology AEMIDF, Vol. 57, No. 1, p 503-509, February 1991, 5 fig, 4 tab, 38 ref.

Descriptors: *Bacterial analysis, *Genetic engineering, *Pollutant identification, *Pseudomonas, *Separation techniques, DNA, Electron microscopy, Enrichment, Enzymes, Immunoassay, Monoclonal antibodies, Plasmids.

A selective recovery immunocapture technique to study the fate of genetically engineered microorganisms in the environment has been developed from work originally done on the isolation of lymphocyte subsets in blood samples. Monoclonal antibodies to Pseudomonas putida Paw340 cells were produced. In an enzyme-linked immunosorbent assay (ELISA) against bacterial cells, a hybridoma cell line termed MLV1 produced a monoclonal antibody that reacted with P. putida Paw 340 but showed no cross-reaction with 100 medical isolates and 150 aquatic isolates. By ELISA, immunogold electron microscopy, and Western blot (immunoblot) analysis, MLV1 antibody was found to react with purified bacterial flagella. The surfaces of magnetic polystyrene beads were coated with MLV1 antibody. By mixing MLV1 antibody-coated beads with lake water samples containing the target P. putida host, bead-cell complexes which could be recovered by attraction towards a magnet were formed. Prevention of nonspecific attachment of cells to the beads required the incorporation of detergents in the isolation protocol. These detergents affected colony-forming ability; however, the cells remained intact for direct detection. When reisolated by standard cultural methods, approximately 20% of the initial target population was recovered. Since the beads and bead-cell complexes were recovered in a magnetic field, target bacteria were separated from other lake water organisms and from particulate material which was not attracted towards the magnet and were thereby enriched. This method may now provide a useful system for recovering recombinant bacteria selectively from environmental samples. (Author's abstract)
W91-07654

DETECTION OF VIABLE LEGIONELLA PNEUMOPHILA IN WATER BY POLYMERASE CHAIN REACTION AND GENE PROBE METHODS.
Louisville Univ., KY. Dept. of Biology.
A. K. Bej, M. H. Mahbubani, and R. M. Atlas.
Applied and Environmental Microbiology AEMIDF, Vol. 57, No. 1, p 597-600, February 1991, 1 fig, 2 tab, 17 ref.

Descriptors: *Bacterial analysis, *Culturing techniques, *DNA, *Genetic engineering, *Legionella, *Pollutant identification, Biocides, Cooling towers, Gene probes, Polymerase chain reaction.

Methods using polymerase chain reaction (PCR) and gene probes to detect viable Legionella pneumophila were investigated with cells exposed to biocide or elevated temperature to determine whether PCR amplification of the mip gene of L. pneumophila detects dead and living bacterial cells. Exposure to hypochlorite caused viable nonculturable cells to form. These have been shown to cause infections in susceptible animals and may be capable of causing legionellosis even after treatment of cooling waters with biocidal disinfectants, yet are not detectable by culturing methods. Culturable and viable nonculturable cells showed positive PCR amplification, whereas nonviable cells did not. Because it is known that in some situations, in which DNA is preserved, dead cells are detected by the PCR-gene probe method, viable cells were also specifically detected with mip mRNA (half-life < 2 min) as the target, reverse transcription (to form cDNA), and PCR amplification. After exposure to elevated temperature, only viable culturable cells were detected, which corresponded with positive PCR amplification. Thus the detection of mip mRNA was specific for viable L. pneumophila. The level of sensitivity for detecting mip mRNA was 1,000 cells compared with single cell sensitivity by direct DNA PCR amplification. The lower sensitivity was probably due to the low efficiency of mRNA extraction and protection. The direct PCR-gene probe method detects viable but nonculturable cells even following biocide treatment. In other situations it may be necessary to use the mRNA-based detection method to establish the presence of viable bacterial cells. (Doyle-PTT)
W91-07655

IMPROVED METHOD FOR COLIFORM VERIFICATION.
Lycoming Coll., Williamsport, PA. Dept. of Biology.
For primary bibliographic entry see Field 7B.
W91-07657

ASSAY FOR BETA-GLUCURONIDASE IN SPECIES OF GENUS ESCHERICHIA AND ITS APPLICATIONS FOR DRINKING-WATER ANALYSIS.
Environmental Protection Agency, Cincinnati, OH.
E. W. Rice, M. J. Allen, D. J. Brenner, and S. C. Edberg.
Applied and Environmental Microbiology AEMIDF, Vol. 57, No. 1, p 592-593, February 1991, 2 tab, 14 ref.

Descriptors: *Bioindicators, *Coliforms, *Escherichia, *Pollutant identification, *Potable water, *Testing procedures, *Water analysis, *Water quality monitoring, Bacterial analysis, Bioassay, Biochemical tests, Biological samples, Fecal coliforms.

Recently, Escherichia species other than Escherichia coli have been isolated from potable water. The total coliform group will remain the primary bacterial indicator, however, for each positive total coliform test, a fecal coliform or E. coli analysis must be performed for that sample. Environmental isolates as well as clinical isolates of E. adecarboxylata, E. blattae, E. fergusonii, E. hermannii, and E. vulneris were assayed for the enzyme beta-glucuronidase (GUR) by using 4-methyl umbelliferyl-beta-glucuronide (MUG) in EC medium and the Colilert system, which also uses MUG. Fluorescence was observed in both procedures by exposing the tubes to long wave UV light (366 nm). Any fluorescence was considered positive for E. coli and therefore evidence of fecal contamination. None of the isolates were positive for the enzyme by either method. The results indicate that assays for GUR in an EC-MUG medium or the Colilert system are able to distinguish E. coli from other Escherichia species. The use of these procedures will allow public health authorities to make deci-

sions based on methods shown to be specific for E. coli and not subject to false positive results. (Doyle-PTT)
W91-07658

APPLICATION OF THE SELF-POTENTIAL METHOD TO GROUNDWATER MONITORING.
Pennsylvania Dept. of Environmental Resources, Harrisburg.
For primary bibliographic entry see Field 2F.
W91-07671

HANDBOOK OF CHEMICAL PROPERTY ESTIMATION METHODS: ENVIRONMENTAL BEHAVIOR OF ORGANIC COMPOUNDS.
For primary bibliographic entry see Field 5B.
W91-07767

VAPOR PRESSURE.
For primary bibliographic entry see Field 5B.
W91-07781

FLASH POINTS OF PURE SUBSTANCES.
For primary bibliographic entry see Field 2K.
W91-07785

DENSITIES OF VAPORS, LIQUIDS AND SOLIDS.
For primary bibliographic entry see Field 2K.
W91-07786

INTERFACIAL TENSION WITH WATER.
For primary bibliographic entry see Field 2K.
W91-07788

LIQUID VISCOSITY.
For primary bibliographic entry see Field 2K.
W91-07789

HEAT CAPACITY.
For primary bibliographic entry see Field 2K.
W91-07790

THERMAL CONDUCTIVITY.
For primary bibliographic entry see Field 2K.
W91-07791

DIPOLE MOMENT.
For primary bibliographic entry see Field 2K.
W91-07792

INDEX OF REFRACTION.
For primary bibliographic entry see Field 2K.
W91-07793

PCDDS IN THE SEDIMENTS ACCUMULATED ABOUT 8120 YEARS AGO FROM JAPANESE COASTAL AREAS.
Ehime Univ., Matsuyama (Japan). Dept. of Environment Conservation.
S. Hashimoto, T. Wakimoto, and R. Tatsukawa.
Chemosphere CMSHAF, Vol. 21, No. 7, p 825-835, 1990. 8 fig, 3 tab, 14 ref.

Descriptors: *Dioxins, *Harima-Nada, *Osaka Bay, *Path of pollutants, *Pollutant identification, *Polychlorinated dibenzo-p-dioxins, Chemical precipitation, Japan, Sediment analysis, Sediment chemistry, Sediment contamination, Water pollution, Water pollution sources.

Previous investigations of sediment cores in Japanese waters revealed the presence of polychlorinated dibenzo-p-dioxins (PCDDs) in surface sediments dated after 1950. Reports have indicated the existence of PCDDs in deep sediments from examinations of core samples obtained from Osaka Bay and Harima-Nada in the Inland Sea, and from one location in Lake Kizaki. The two locations in the Inland Sea are situated near large cities and are affected by industry while Lake Kizaki is not located near any large population centers. In addition to PCDD analysis, age determinations were also calculated for the sediment cores. PCDDs were found in all samples from Osaka Bay and Harima-Nada, while no PCDD compounds were detected for the Lake Kizaki core samples. However, it must be noted that PCDDs were detected from whole sediment cores from Osaka Bay and Harima-Nada, and PCDDs were found in the deepest sediments from Harima-Nada; the sedimentation age for this core sample was calculated to be 8120 years old. The possibility of contamination was ruled out. Precipitation rates of PCDDs, around a depth of 200 cm, were estimated to be about 4.9 and 5.4 pg/sq cm/yr in Osaka Bay and Harima-Nada, respectively. These similar values, along with a uniform congener composition in the whole cores, indicated that the PCDD sources existed before industry developed in the area. (Korn-PTT)
W91-07837

BIOACCUMULATION OF ZINC AND CADMIUM IN FRESHWATER ALGA, CHLORELLA VULGARIS, PART II. ASSOCIATION MODE OF THE METALS AND CELL TISSUE.
Kagoshima Univ. (Japan). Dept. of Applied Chemistry.
For primary bibliographic entry see Field 5B.
W91-07842

ORGANIC COMPOUNDS IN PRECIPITATION.
Fraunhofer-Inst. fuer Toxikologie und Aerosolforschung, Hanover (Germany, F.R.).
For primary bibliographic entry see Field 2B.
W91-07844

DETERMINATION AND OCCURRENCE OF AHH-ACTIVE POLYCHLORINATED BIPHENYLS, 2,3,7,8-TETRACHLORO-P-DIOXIN AND 2,3,7,8-TETRACHLORODIBENZOFURAN IN LAKE MICHIGAN SEDIMENT AND BIOTA. THE QUESTION OF THEIR RELATIVE TOXICOLOGICAL SIGNIFICANCE.
Fish and Wildlife Service, Columbia, MO.
For primary bibliographic entry see Field 5B.
W91-07845

WATER AND WASTEWATER EXAMINATION MANUAL.
Tennessee Technological Univ., Cookeville. Dept. of Civil Engineering.
V. D. Adams.
Lewis Publishers, Chelsea, Michigan. 1990. 247p.

Descriptors: *Pollutant identification, *Wastewater analysis, *Water analysis, *Water quality, Biological properties, Inorganic compounds, Manuals, Metals, Organic compounds, Physical properties.

This manual was written using newly revised procedures from 'Standard Methods for the Examination of Water and Wastewater', 'Microbial Methods for Monitoring the Environment: Water and Wastes, Methods for Chemical Analysis of Water and Wastes', and other pertinent references. It is intended to be used as a working laboratory guide and reference to water quality analysis for upper level undergraduates, graduate students, water quality technicians, and water and wastewater plant operators. Procedures are included for parameters that are frequently needed in water quality analysis, and include methods for: (1) determining physical properties; (2) determining the presence of metals; (3) determining inorganics and nonmetals; (4) determining organics; and (5) biological determination. In general, the analytical procedures have been thoroughly examined and tested in the Water Quality Laboratory at the Utah Water Research Laboratory, Utah State University, Logan, Utah and the Water Quality Laboratory at the Center for the Management, Utilization, and Protection of Water Resources, Tennessee Technological University, Cookeville, Tennessee. The procedures in this manual were selected from many available methods; the tests included here are those that are commonly used in water and wastewater laboratories. (Lantz-PTT)
W91-07906

SEPARATION OF WATER SAMPLES INTO SESTON AND WATER FOR THE DETERMINATION OF ORGANIC POLLUTANTS (TRENNUNG VON WASSER IN SCHWEBSTOFFE UND WASSER ZUR BESTIMMUNG ORGANISCHER SPURENSTOFFE IN OBERFLAECHENGEWAESSERN).
GKSS - Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.).
R. Sturm, J. Gandrass, P. Milde, and E. H. Ermert.
Zeitschrift fuer Wasser- und Abwasser Forschung ZWABAQ, Vol. 23, No. 6, p 217-220, December 1990, 2 fig, 1 tab, 8 ref. English summary.

Descriptors: *Organic pollutants, *Pollutant identification, *Sample preparation, *Separation techniques, *Suspended solids, *Water analysis, Analytical methods, Centrifugation, Pumps, Seston, Water quality monitoring, Water sampling.

The Examination of ecologically important substances for water quality assessments necessitates the separation of water samples into seston and aqueous components, due to the differing behavior of suspended matter and the water in which it is suspended. An apparatus which based on inertial separation has been developed facilitates the separation of the particulate matter from the water phase. The apparatus allows the removal of the particulate matter from hundreds of liters of water, and yields the gram quantities of suspended matter needed for the relevant trace substance analysis. The apparatus consists primarily of an underwater pump, a reservoir, and a continuous flow centrifuge. All material used in construction is stainless steel/PTFE. To avoid all contamination problems, the compact centrifuge is hung on double gimbals, allowing flexible use of the apparatus at both land-based and vehicle-based sites, as well as on research vessels. (Author's abstract)
W91-07988

GAS-CHROMATOGRAPHIC DETERMINATION OF SUBSTITUTED ANILINES IN WATER AFTER SOLID-PHASE EXTRACTION (BESTIMMUNG VON SUBSTITUIERTEN ANILINEN IN WASSER DURCH GASCHROMATOGRAPHIE NACH FESTPHASENEXTRAKTION).
Muenster Univ. (Germany, F.R.). Inst. fuer Lebensmittelchemie.
G. Boer, C. Schlett, and H. P. Thier.
Zeitschrift fuer Wasser- und Abwasser Forschung ZWABAQ, Vol. 23, No. 6, p 220-223, December 1990, 1 fig, 1 tab, 14 ref. English summary.

Descriptors: *Analytical methods, *Anilines, *Gas chromatography, *Pollutant identification, *Separation techniques, *Water analysis, Chemical interference, Detection limits, Drinking water, Herbicides, Laboratory methods, Precision.

An analytical method was developed for the determination of 13 substituted anilines in drinking and surface water samples. It involves extraction by C18 reverse phase material, elution with ethyl acetate and capillary gas chromatography using cold on-column injection and an nitrogen-specific detector. A 30 m x 0.25 mm x 0.25 microm separation column was used with RP-C18 solid phase extraction material. The compounds analyzed included aniline, 4-bromoanaline, 2-chloroaniline, 3-chloroaniline, 4-chloroaniline, 4-chloro-2-methlylaniline, 3-chloro-4-methylaniline, 3-chloro-4-methoxyaniline, 2,4-dichloroaniline, 2,5-dichloroaniline, 2,6-dichloroaniline, 3,4-dichloroaniline, 4-isopropylaniline. Heptanoyl nitrile and Octanoyl nitrile were used as internal standards. Recoveries for 0.1 microg/L of each aniline compound which were added to the surface water samples generally ranged from 70 to 80% with good precision. The routine limit of determination was approximately 0.025 microg/L. Phenyl urea herbicides interfere only when present at levels of more than 2 to 5 microg/L. (King-PTT)
W91-07989

UREASE-AGAR-DIFFUSION-TEST FOR RAPID DETERMINATION OF THE TOXICITY OF SURFACE WATERS (DER UREASE-AGAR-DIFFUSIONSTEST ZUR SCHNELLEN TOXIZITAETSBESTIMMUNG VON OBERFLAECHENGEWAESSERN).
Universitaet des Saarlandes, Homburg/Saar (Germany, F.R.). Medizinische Fakultaet.
A. Neufang, O. vonFalkenhausen, and R. Schweisfurth.
Zeitschrift fuer Wasser- und Abwasser Forschung ZWABAQ, Vol. 23, No. 6, p 223-228, December 1990, 2 fig, 3 tab, 6 ref.

Descriptors: *Analytical methods, *Heavy metals, *Inhibition, *Toxicity, *Toxicology, *Water pollution, Cadmium, Chromium, Copper, Cyanide, Mercury, Organic pollutants, Zinc.

An enzymatic toxicity test for the toxicological examination of water samples, based on the inhibition of urease by toxic substances, in particular by several heavy metals was developed. Calibration curves for the heavy metals Hg(II), Cu(II), Cd(II), Zn(II), and Cr(II) were determined and the effect of mixtures of two heavy metals was examined. In addition, 15 organic toxicants and cyanide ions were tested for their influence on urease inhibition. The detection limit of the test was determined to be 0.1 ppb for Hg(II) and Zn(II), 10 ppb for Cu(II) and 100 ppb for Cd(II) and Cr(III); of the organic toxicants tested, mercaptobenzothiazole, oxalic acid, p-methoxybenzaldehyde and formaldehyde had the greatest inhibitory effect on urease. Trichloroethylene and phenol showed no urease inhibition up to a concentration of 100 ppm. In 23 of more than 100 water samples, taken from the river Saar, its tributaries, and several small brooks (Nied, Prims, and Blies), urease inhibition was found and the inhibiting effect was transformed to mercury equivalent values. (Author's abstract)
W91-07990

EVALUATION OF WASTE WATER TOXICITY WITH THREE CYTOTOXICITY TESTS.
Munich Univ. (Germany, F.R.). Inst. fuer Zoologie and Hydrobiologie.
M. Halder, and W. Ahne.
Zeitschrift fuer Wasser- und Abwasser Forschung ZWABAQ, Vol. 23, No. 6, p 233-236, December 1990, 3 tab, 15 ref.

Descriptors: *Analytical methods, *Cytotoxicity, *Testing procedures, *Toxicity, *Toxicology, *Wastewater analysis, Cell cultures, Cytology, Germany, Minnow, Performance evaluation, Regulations.

Currently, the German Waste Water Act requires the 'fish test'--in which mortality of the test organism, the golden ide (Leuciscus idus melanotus), is used as the measure of toxicity--for determining the toxicity of wastewaters. This use of the test animals is in conflict with the German Animal Welfare Act. Fish cell cultures have been suggested as possible alternatives to reduce or replace the live fish test. The cytotoxicity of 97 waste waters were determined from fish cell cultures using as the endpoints cell attachment, morphology, cell number and cell viability. The results of fish tests using live golden ide were compared with the results of cytotoxicity tests which were performed in parallel on the same wastewaters. Cell attachment was determined microscopically on plates stained with crystal violet. Cell morphology and cell number were determined with the R1 cytotoxicity test, which uses a permanent fibroblastic fish-cell culture (R1 cells). Cell viability was assayed with the vital dyes neutral red and MTT (3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyl tetrazolium bromide). The photometrically-evaluated R1 cytotoxicity test showed the highest detection rate (23%) and the best agreement (89%) with the fish test, as measured by the lowest dilution of a wastewater which causes no cytotoxicity within 24 hours (GZ value) or fish toxicity within 48 hours (GF value). The results confirm the ability of fish-cell-culture cytotoxicity tests to detect waste toxicity as required by the German Waste Water Act. (King-PTT)
W91-07992

RESPIROMETRIC DETERMINATION OF WASTEWATER BIODEGRADATION IN A BIOLOGICAL TREATMENT PLANT.
Kemijski Inst. Boris Kidric, Ljubljana (Yugoslavia).
For primary bibliographic entry see Field 5D.
W91-07993

INTER-ELEMENT INTERFERENCE STUDIES IN THE DETERMINATION OF TRACE AMOUNTS OF PLUTONIUM BY INDUCTIVELY COUPLED PLASMA-ATOMIC EMISSION SPECTROMETRY.
Bhabha Atomic Research Centre, Bombay (India). Radiochemistry Div.
M. J. Kulkarni, S. K. Thulasidas, N. Goyal, A. G. Page, and M. D. Sastry.
Analytical Letters ANALBP, Vol. 23, No. 11, p 2095-2106, November 1990. 3 tab, 10 ref.

Descriptors: *Analytical methods, *Chemical analysis, *Plutonium, *Pollutant identification, *Water analysis, Detection limits, Emission spectrometry, Lanthanide elements, Thorium, Trace levels, Uranium.

Trace amounts of plutonium in aqueous solutions have been determined by an inductively coupled argon plasma-atomic emission spectrometric technique. Extensive studies have been carried out on inter-element interference effects for two plutonium lines, viz., 300.06 nm and 453.6 nm, due to the presence of uranium, thorium, lanthanides and other metallic elements in the sample solutions. The analytical range obtained was 0.1 to 100 microg/ml, with a precision of better than 1% relative standard deviation. Analysis of reference standards indicated close agreement (within 4%) between expected and observed plutonium amounts. The inter-element effect studied for both plutonium lines permitted the following conclusions: (1) plutonium determination at 10 microg/L is free from any interference due to the presence of 13 metallic elements at ten times the analyte amount; (2) the concomitant presence of 13 lanthanide elements does not effect plutonium determination; and (3) neither of the analytical lines show any interference due to the presence of uranium and thorium at up to 5 times the analyte amount. (MacKeen-PTT)
W91-07996

TOXICITY OF MICROENCAPSULATED PERMETHRIN TO SELECTED NONTARGET AQUATIC INVERTEBRATES.
Guelph Univ. (Ontario). Dept. of Environmental Biology.
For primary bibliographic entry see Field 5C.
W91-07998

CHEMOMETRIC COMPARISON OF POLYCHLORINATED BIPHENYL RESIDUES AND TOXICOLOGICALLY ACTIVE POLYCHLORINATED BIPHENYL CONGENERS IN THE EGGS OF FORSTER'S TERNS (STERNA FORSTERI).
Fish and Wildlife Service, Columbia, MO.
T. R. Schwartz, and D. L. Stalling.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 20, No. 2, p 183-199, February 1991. 6 fig, 6 tab, 47 ref.

Descriptors: *Analytical methods, *Aroclors, *Pollutant identification, *Polychlorinated biphenyls, *Toxicology, *Water birds, Bird eggs, Data interpretation, Gas chromatography, Model studies, Wisconsin.

The separation and characterization of complex mixtures of polychlorinated biphenyls (PCBs) was approached from the perspective of a problem in chemometrics. A congener-specific procedure was utilized for the determination of PCBs in which n-alkyl trichloroacetates are used as retention index marker compounds. Retention indices were reproducible in the range of +/-0.05 to +/-0.07 depending on the specific congener. A laboratory data base system developed to aid in the editing and quantitation of data generated from capillary gas chromatography was employed to quantitate chromatographic data. In the chemometric evaluation of these complex chromatographic profiles, data are viewed from a single analysis as a point in multi-dimensional space. Principal Components Analysis was used to obtain a representation of data in lower dimensional space. Analysis of eggs collected from Forster's tern colonies near Lake Poygan and Green Bay, Wisconsin, indicated average total PCB concentrations of 4.79 and 21.0 mg/kg, respectively. Profiles of PCB constituents differed between bird eggs of the two colonies. Furthermore, residues could not be accurately represented as Aroclor equivalents. (MacKeen-PTT)
W91-08000

SENSITIVITY OF CERIODAPHNIA DUBIA AND DAPHNIA MAGNA TO SEVEN CHEMICALS UTILIZING THE THREE-BROOD TEST.
Dow Chemical Co., Midland, MI. Environmental Toxicology and Chemistry Research Lab.
U. M. Cowgill, and D. P. Milazzo.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 20, No. 2, p 211-217, February 1991. 9 tab, 18 ref.

Descriptors: *Analytical methods, *Bioassay, *Pollutant identification, *Toxicity, *Toxicology, *Water quality monitoring, *Waterfleas, Alcohols, Daphnia, Lethal limit, Organic compounds, Phenols, Three-brood test, Trihalomethanes.

The sensitivity of Ceriodaphnia dubia and Daphnia magna to ethanol, acetone, phenol, 4-chlorphenol, trichloromethane, diethanolamine and chlorobenzene was investigated using the three-brood test. Total progeny, number of broods and mean brood size provided results of the same order of magnitude for each compound for a specific organism. Dry weight proved to be a poor endpoint. The response of C. dubia to six compounds failed to provide a determinable EC50 due to a lack of significance of the regression equation. In the case of D. magna, only five of the seven compounds provided a determinable result for dry weight. Compared to the results based on total progeny, number of broods and mean brood size, dry weight results in the absolute sense for D. magna were less sensitive for ethanol, phenol, 4-chlorophenol, more sensitive for trichloromethane, and about the same for diethanolamine as were the results for total progeny. For both cladocerans, progeny was the most sensitive endpoint for ethanol. For the other six compounds, survival at the end of the three-brood test provided LC50/EC50 results of the same order of magnitude as progeny, number of broods and mean brood size. The three-brood test results for D. magna prove this organism to be the most sensitive to four of the seven compounds, among other organisms that have been tested. (Author's abstract)
W91-08001

EFFECTS OF METALS ON EARLY LIFE STAGES OF THE BRINE SHRIMP, ARTEMIA: A DEVELOPMENTAL TOXICITY ASSAY.
Dalhousie Univ., Halifax (Nova Scotia). Dept. of Biology.
T. H. MacRae, and A. S. Pandey.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 20, No. 2, p 247-252, February 1991. 4 fig, 25 ref.

Descriptors: *Bioassay, *Bioindicators, *Brine shrimp, *Heavy metals, *Metals, *Pollutant identification, *Toxicity, Analytical methods, Aquatic animals, Coastal waters, Copper, Lead, Life cycles, Nickel, Toxic metals, Water quality monitoring, Zinc.

The influence of four metals, cupric sulfate, lead nitrate, zinc sulfate and nickel sulfate, on emergence and hatching of the brine shrimp, Artemia, was assessed. Occurrence of these easily measured milestones provides a convenient method to assay metal effects on development. Copper and lead were about equally toxic, reducing the rate and extent of Artemia development at or below concentrations of 0.1 microM. Zinc was somewhat less toxic than copper and lead, while nickel was the least toxic. Emerging Artemia were much more

sensitive to metals than were larvae and adults. Furthermore, in contrast to results obtained with larvae and adults, the toxicity of lead was high when prelarval stages were considered. It is concluded from these findings that use of early stages of Artemia is an alternative to the examination of slower growing animals for the study of metal pollution in coastal marine waters. (Author's abstract)
W91-08005

CHLORINATED AND METHYLATED DIBENZOTHIOPHENES: PREPARATION OF THE MODEL COMPOUNDS AND THEIR ANALYSIS FROM SOME ENVIRONMENTAL SAMPLES.
Jyvaeskylae Univ. (Finland). Dept. of Chemistry.
S. Sinkkonen, and J. Koistinen.
Chemosphere CMSHAF, Vol. 21, No. 10/11, p 1161-1171, 1990. 7 fig, 1 tab, 13 ref.

Descriptors: *Analytical methods, *Chemical analysis, *Chlorinated hydrocarbons, *Laboratory methods, *Pollutant identification, Dibenzothiophenes, Environmental samples, Gas chromatography, Mass spectrometry, Sediment analysis, Synthesis, Tissue analysis, Water analysis.

Several chlorinated and methylated dibenzothiophenes have been synthesized to serve as model compounds in environmental and toxicological analysis. Samples investigated included Baltic salmon, a Baltic seal, pulp mill effluent, a sediment, and incubated mussel samples. The retention times and mass spectra obtained for the compounds made it possible to analyze these compounds in some environmental samples. In low resolution mass spectrometry, the chlorinated dibenzothiophenes have the same M+, M+2, and M+4 ions as the corresponding chlorinated dibenzo-p-dioxins. There is also interference from other compounds with the same retention times as the chlorinated dibenzothiophenes, necessitating further purification of environmental samples. Results indicated that the concentrations of the polychlorinated and polymethylated dibenzothiophenes in environmental samples were below the ppb level, but did not exclude the possibility of the compounds occurring in the environment. (MacKeen-PTT)
W91-08017

ANALYSIS OF POLYCHLORINATED DIBENZO-P-DIOXINS (PCDD) AND POLYCHLORINATED DIBENZOFURANS (PCDF) IN SOIL AND DIGESTED SEWAGE SLUDGE FROM STOCKHOLM, SWEDEN.
Stockholm Univ. (Sweden). Dept. of Zoology.
For primary bibliographic entry see Field 5E.
W91-08020

IMPORTANCE OF CLOSELY SPACED VERTICAL SAMPLING IN DELINEATING CHEMICAL AND MICROBIOLOGICAL GRADIENTS IN GROUNDWATER STUDIES.
Geological Survey, Lakewood, CO. Water Resources Div.
R. L. Smith, R. W. Harvey, and D. R. LeBlanc.
Journal of Contaminant Hydrology JCOHE6, Vol. 7, No. 3, p 285-300, February 1991. 8 fig, 24 ref.

Descriptors: *Bacterial analysis, *Chemical analysis, *Groundwater pollution, *Path of pollutants, *Pollutant identification, *Water quality monitoring, *Water sampling, Cape Cod, Dissolved oxygen, Environmental gradient, Massachusetts, Pollutants, Unconfined aquifers.

Vertical gradients of selected chemical constituents, bacterial populations, bacterial activity and electron acceptors were investigated for an unconfined aquifer with nitrate and organic compounds on Cape Cod, Massachusetts. Fifteen-port multilevel sampling devices were installed within the contaminant plume at the source of the contamination, and at 250 and 2100 m downgradient from the source. Depth profiles of specific conductance and dissolved oxygen at the downgradient sites exhibited vertical gradients that were both steep and inversely related. Narrow zones (2-4 m thick) of high nitric oxide and ammonium concentrations were also detected within the contaminant plume. A 27-fold change in bacterial abundance; a 35-fold change in frequency of dividing cells, an indicator of bacterial growth; a 23-fold change in tritiated glucose uptake, a measure of heterotrophic activity; and substantial changes in overall cell morphology were evident within a 9-m vertical interval and at 250 m downgradient. The existence of these gradients argues for the need for closely spaced vertical sampling in groundwater studies because small differences in the vertical placement of a well screen can lead to incorrect conclusions about the chemical and microbiological processes within an aquifer. (Author's abstract)
W91-08043

MARINE POLLUTION BIOASSAY BY SEA URCHIN EGGS, AN ATTEMPT TO ENHANCE SENSITIVITY.
Doshisha Univ., Kyoto (Japan). Biological Lab.
N. Kobayashi.
Publications of Seto Marine Biological Laboratory PSMPAO, Vol. 34, No. 4/6, p 225-237, August 1990. 1 fig, 8 tab, 10 ref.

Descriptors: *Bioassay, *Echinoderms, *Marine animals, *Marine pollution, *Pollutant identification, *Toxicology, Analytical methods, Animal physiology, Eggs, Hatakejima Island, Japan, Larvae.

A sensitive method for marine pollution bioassy utilizes developing sea urchin (Anthocidaris crassispina and Hemicentrotus pulcherrimus) eggs and larvae. Rates of first cleavage, pluteus formation and some abnormalities in development were checked in eggs exposed to water samples at 26 and 18 C. In a departure from previous methods, the embryos or larvae deposited on the bottom were also examined in the assay. Examination of the effect of some chemicals on the first cleavage and pluteus formation indicated an inhibitory effect of the following chemicals, in order of decreasing magnitude: Cu, Zn, Ni, Cd, Mn, Co, ABS, and ammonia. Bioassay of water from four stations around Hatakejima Island indicated that teh degree of pollution was more pronounced on the land side of the island, where the water is heavily polluted by waste products of fish rearing and otehr wastes. On the basis of the results, a new ranking system of sea water pollution (Ranking IV) having four inhibitory degrees is proposed. (MacKeen-PTT)
W91-08044

EFFECT OF STORAGE CONDITIONS AND SUBCELLULAR FRACTIONATION OF FISH LIVER ON CYTOCHROME P-450-DEPENDENT ENZYMATIC ACTIVITIES USED FOR THE MONITORING OF WATER POLLUTION.
Ecole Nationale Veterinaire de Lyon (France). Lab. d'Ecotoxicologie.
G. Monod, and E. Vindimian.
Water Research WATRAG, Vol. 25, No. 2, p 173-177, February 1991. 6 fig, 13 ref.

Descriptors: *Bioindicators, *Enzymes, *Fish, *Monitoring, *Sample preparation, France, Liver, Polychlorinated biphenyls, Rhone River, Sample preservation, Water pollution.

Hepatic cytochrome P-450-dependent monooxygenase activities of fish, especially O-deethylase activity (EROD activity) have been proposed as possible indicators of water pollution. Nevertheless, there is a need for comparisons between different methods of storage and of subcellular fractionation of the liver with regard to absolute activity and responsiveness of EROD activity to pollution. Livers of nase (Chondrostoma nasus) were collected in PCB-polluted and reference areas of the River Rhone. They were stored in liquid nitrogen either after slicing or after homogenization in phosphate buffer containing 20% glycerol; subcellular fractionations were performed at the laboratory. Results demonstrate the deleterious effect of freezing slices of liver on EROD activity and point out the protective effect of homogenizing in buffer containing 20% glycerol (a cryoprotector) prior to freezing. Moreover, a 3-fold higher EROD activity was observed in the microsomal fraction as compared to the postmitochondrial fraction. Finally, no difference was noted between methods of storage and of subcellular preparation with regard to the rate of induction of EROD activity between polluted and reference areas. It is concluded that, in most cases, the postmitochondrial fraction from the liver homogenized in buffer containing 20% glycerol prior to freezing in liquid nitrogen is a useful preparation for measuring EROD activity as a pollution indicator. (Author's abstract)
W91-08051

EFFECT OF HEAVY METALS ON SHORT-TERM PHOTOSYNTHETIC RATES IN POTAMOGETON AMPLIFOLIUS.
Oral Roberts Univ., Tulsa, OK. Dept. of Biology.
For primary bibliographic entry see Field 5C.
W91-08077

ACUTE TOXICITY OF PETROLEUM HYDROCARBONS TO THE ARCTIC SHALLOW-WATER MYSID, MYSIS OCULATA (FABRICIUS).
Arctic Biological Station, Ste. Anne de Bellevue (Quebec).
For primary bibliographic entry see Field 5C.
W91-08085

SIGNIFICANCE OF FRACTIONATION METHODS IN ASSESSING THE CHEMICAL FORM OF PHOSPHATE ACCUMULATED BY ACTIVATED SLUDGE AND AN ACINETOBACTER PURE CULTURE.
Council for Scientific and Industrial Research, Pretoria (South Africa). Div. of Water Technology.
For primary bibliographic entry see Field 5D.
W91-08087

IMPORTANCE, DETERMINATION, AND OCCURRENCE OF INORGANIC CHEMICAL CONTAMINANTS AND NUTRIENTS IN SOUTH AFRICAN MUNICIPAL SEWAGE SLUDGES.
Council for Scientific and Industrial Research, Pretoria (South Africa). Div. of Water Technology.
For primary bibliographic entry see Field 5E.
W91-08089

COMPLETE ANALYSIS OF TECHNICAL CHLORDANE USING NEGATIVE IONIZATION MASS SPECTROMETRY.
Indiana Univ., Bloomington. School of Public and Environmental Affairs.
M. A. Dearth, and R. A. Hites.
Environmental Science and Technology ESTHAG, Vol. 25, No. 2, p 245-254, February 1991. 6 fig, 1 tab, 26 ref. U. S. Department of Energy grant 87ER-60530.

Descriptors: *Pollutant identification, *Pesticides, *Chlorinated hydrocarbons, *Insecticides, *Chlordane, Analytical methods, Separation techniques, *Mass spectrometry, Gas chromatography, X-ray diffraction, Fates of pollutants, Pesticide residues.

Technical chlordane, a mixture of more than 140 compounds, was a pesticide that was used until 1988 when both sale and use were voluntarily suspended. Because of its persistence, an estimated 25-50% of all the technical chlordane ever produced still exists unaltered in the environment. Using electron capture, negative ionization mass spectrometry combined with high-resolution gas chromatography, more than 120 components of technical chlordane have been resolved. The components identified include chlorbicyclen and related compounds, compounds based on a C-11 carbon skeleton, and compounds based on a C-15 carbon skeleton. Many additional isomers of C-10 derived compounds have also been separated and tentatively identified. X-ray crystallography was used to confirm the structures of alpha, beta, gamma and isomer II chlordane, thus resolving conflicting reports in previous literature. Gas chromatographic retention data as well as electron capture, negative ion mass spectral features used to discern structural characteristics for 147 components of technical chlordane are presented. These data should be

useful to workers interested in identifying and quantitating chlordane's many components wherever they are found. (Doyle-PTT)
W91-08099

RARE EARTH ELEMENTS IN SEDIMENTS OFF SOUTHERN CALIFORNIA: A NEW ANTHROPOGENIC INDICATOR.
Massachusetts Inst. of Tech., Cambridge. Nuclear Reactor Lab.
For primary bibliographic entry see Field 5B.
W91-08105

CHROMATOGRAPHIC SEPARATION AND DETERMINATION OF CARCINOGENIC BENZ(C)ACRIDINES IN CREOSOTE OILS.
Meiji Coll. of Pharmacy, Tokyo (Japan).
N. Motohashi, K. Kamata, and R. Meyer.
Environmental Science and Technology ESTHAG, Vol. 25, No. 2, p 342-346, February 1991, 4 fig, 2 tab, 32 ref.

Descriptors: *Analytical techniques, *Aromatic compounds, *Chromatography, *Creosote, *Pollutant identification, *Separation techniques, Coal tars, Fluorescence, Gas chromatography, High performance liquid chromatography, Mass spectrometry.

Only a few of the theoretically possible isomers of methyl-substituted benz (c) acridines (BAcs) exhibit high carcinogenic activity, yet one of the most challenging problems arising from the analysis of such substances is the identification of individual isomers in the BAcs molecules. A separation and detection scheme has been developed for the unambiguous identification of benz(c)acridines and their methyl-substituted congeners (BAcs) found in creosote oils, a complex mixture of coal tar distillates. After selective enrichment (including liquid/liquid-acid/base partition, column chromatography on Sephadex LH 20 and ion-exchange chromatography), basic fractions of a creosote oil sample were analyzed by high performance liquid chromatography (HPLC) with fluorescence detection and subsequent capillary gas chromatography with a thermionic specific detector (TSD). A basis fraction was further separated by HPLC and followed by thin-layer chromatography (HPTLC). The subfractions were examined in detail by gas chromatography-mass spectrometry (GC-MS) and fluorescence spectrophotometry. This approach leads to the positive identification of many specific BAcs. The concentrations of identified BAcs (benz(c)acridine, 9-methylbenz(c)acridine, and 10-methylbenz(c)acridine) in creosote oil were at the levels of 7.7, 18.4, and 192.7 micrograms/gram respectively. (Doyle-PTT)
W91-08107

DETERMINATION OF PHOSPHATE IN WATERS BY FLOW INJECTION ANALYSIS.
Universitat de les Illes Balears, Palma de Mallorca (Spain). Dept. de Chemistry.
For primary bibliographic entry see Field 2K.
W91-08122

CHANGES IN ULTRAWEAK LUMINESCENCE FROM LIVING FISH INDUCED BY THREE CHEMICALS.
Beijing Municipal Research Inst. of Environmental Protection (China).
For primary bibliographic entry see Field 5C.
W91-08164

EFFECT OF STARVATION ON TRACE METAL LEVELS IN BLUE MUSSELS (MYTILUS EDULIS).
Department of Fisheries and Oceans, Halifax (Nova Scotia). Physical and Chemical Sciences Branch.
C. L. Chou, and J. F. Uthe.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 46, No. 3, p 473-478, March 1991. 2 tab, 18 ref.

Descriptors: *Bioaccumulation, *Bioindicators, *Bivalves, *Monitoring, *Nutrition, *Path of pollutants, *Sea mussels, *Trace metals, Animal physiology, Animal tissues, Coasts, Excretion, Heavy metals, Marine pollution, Starvation, Tissue analysis.

The use of bivalves as monitors of marine coastal contamination has become widespread, however, many investigations have shown that numerous factors affect contaminant concentrations, in particular trace metals, in mussel tissues. An investigation was made of the effect of starvation on a number of trace elements in blue mussels (Mytilus edulis) to determine which elements were not eliminated as the animal starved (a 'burden' control model) and which elements were excreted (a 'concentration' control model) in response to decreasing tissue weight. Mussels were collected in the vicinity of Petit Rocher, New Brunswick, Canada, approximately 10 km from a coastal lead smelter. Twenty-five were analyzed one day later, and a second group was held in filtered, flowing seawater for 3 months without feeding prior to autopsy and trace elemental determinations. Starvation had no effect on either shell length or total weight, however, a substantial decline (43.3%) in soft tissue weight was observed. Substantial differences were observed in the responses of trace metal concentrations and burdens to starvation. Neither a significant amount of cadmium (Cd), copper (Cu), nor magnesium (Mg) were eliminated during starvation, resulting in significant increases in concentrations of the soft tissue mass but without any significant changes in its metal burden. Starvation resulted in a significant drop in zinc (Zn), arsenic (As) and lead (Pb) in the tissue burden, whereas the Zn, Sn, and Pb concentrations remained unchanged. Both silver (Ag) concentration and burden were increased by starvation. Manganese (Mn), selenium (Se), and iron (Fe) concentrations increased significantly over the starvation period while the burdens showed significant decreases. These results show that trace metals in mussels are under the influence of a variety of mechanisms. Results suggest that modeling the mussel system will be complex and may necessitate dealing with trace metals on both an individual and interactive basis. (VerNooy-PTT)
W91-08167

RECENT METHODS FOR THE DETERMINATION OF VOLATILE AND NON-VOLATILE ORGANIC COMPOUNDS IN NATURAL AND PURIFIED DRINKING WATER.
Centre de Recherche Lyonnaise des Eaux - Degremont, Le Pecq (France).
A. Bruchet, M. F. Legrand, P. Arpino, and D. Dilettato.
Journal of Chromatography. Biomedical Applications JCBADL, Vol. 562, p 469-480, 1991. 11 fig, 2 tab, 14 ref.

Descriptors: *Chemical analysis, *Chromatography, *Dissolved organic carbon, *Drinking water, *Laboratory methods, *Pollutant identification, *Separation techniques, Analytical methods, Mass spectrometry, Organic pollutants, Preconcentration, Reviews.

Four analytical protocols for the extraction and preconcentration of organic residues in natural or purified drinking water were investigated and compared: closed loop stripping analysis; simultaneous extraction-distillation; purge and trap analysis; and continuous liquid-liquid extraction. Organic extracts were submitted to a variety of separation and identification techniques. Volatiles were determined by conventional capillary column gas chromatography with tandem mass spectrometry, using triple-stage quadrupole instruments. Non-volatile and thermally labile molecules were investigated by several different techniques, i.e, high-temperature gas chromatography, capillary column supercritical fluid chromatography, pyrolysis gas chromatography-mass spectrometry, thermospray liquid chromatography with tandem mass spectrometry and conventional fast-atom bombardment with tandem mass spectrometry. Several samples recently examined in the laboratory provide examples of this multi-technique approach for a more complete knowledge of the organic carbon distribution in water-dissolved matter, taking into account organic substances with widely different volatilities, polarities and thermal stabilities. Methods described are not intended to be exhaustive and definitive, but are an array of experimental methods that can be used routinely in the laboratory for odor and taste-quality controls, and for the determination of macromolecules of biological origin that may have a significant bearing on the efficiency of water purification processes. (Author's abstract)
W91-08177

GAS CHROMATOGRAPHIC-MASS SPECTROMETRIC CHARACTERIZATION OF VOLATILE ORGANIC COMPOUNDS IN BARCELONA TAP WATER.
Institut d'Estudis Catalans, Barcelona (Spain).
For primary bibliographic entry see Field 5F.
W91-08178

GAS CHROMATOGRAPHIC-MASS SPECTROMETRIC ANALYSIS OF URBAN-RELATED AQUATIC AND AIRBORNE VOLATILE ORGANIC COMPOUNDS: STUDY OF THE EXTRACTS OBTAINED BY WATER CLOSED-LOOP STRIPPING AND AIR ADSORPTION WITH CHARCOAL AND POLYURETHANE FOAM.
Centro de Investigacion y Desarrollo, Barcelona (Spain). Dept. of Environmental Chemistry.
A. Rosell, J. I. Gomez-Belinchon, and J. O. Grimalt.
Journal of Chromatography. Biomedical Applications JCBADL, Vol. 562, p 493-506, 1991. 3 fig, 2 tab, 31 ref.

Descriptors: *Air pollution, *Gas chromatography, *Mass spectrometry, *Pollutant identification, *Stream pollution, *Urban areas, *Volatile organic compounds, Adsorption, Barcelona, Benzenes, Chlorinated hydrocarbons, Distribution, Hydrocarbons, Path of pollutants, Rivers, Spain, Volatility, Water sampling.

The distribution of volatile organic compounds (VOC) in urban-influenced air and river waters was investigated. Samples were taken from the waters of the Besos and Llobregat Rivers and from the air in Barcelona, Spain. The aquatic VOC were extracted with the closed-loop stripping technique (CLST) and the airborne compounds were studied using two methods, charcoal and polyurethane foam adsorption. In both types of samples, C1 to C5 alkylbenzenes and n-alkanes constituted the two major VOC groups, and the presence of these groups indicated a predominance of petroleum products in these two environmental compartments. Chlorinated compounds such as polychlorobenzenes, polychloronaphthalenes and hexachlorobutadiene were abundant in water samples, whereas tetrachloroethane was the predominant chlorinated airborne VOC. The compounds collected with each sampling system (adsorbent) were described in terms of ranges of volatility. These ranges (expressed as mm Hg vapor pressure at 25 C) were defined approximately as 140 (methyl cyclopentane) to 0.65 (n-undecane) for charcoal, 5.1 (n-nonane) to 0.000061 (n-docosane) for polyurethane foam and 29 (toluene) to 0.00029 (n-eicosane) for the CLST. Parallel air sampling with charcoal and polyurethane foam was therefore needed to cover a VOC range similar to that afforded by the CLST in water. The charcoal extracts, however, were very significant from an environmental standpoint. Their VOC represented the dominant petrogenic sources in the urban atmosphere, being between 1 and 2 orders of magnitude more concentrated than the compounds collected by polyurethane adsorption. Further, the charcoal VOC have been selected as target compounds in monitoring studies on atmospheric health hazards. (Author's abstract)
W91-08179

ORGANIC CHEMICAL ANALYSIS OF GROUND WATER IN LOUISIANA: WATER YEARS 1984-88.
Geological Survey, Baton Rouge, LA. Water Resources Div.
C. G. Stuart, and C. R. Demas.

Louisiana Department of Transportation and Development, Water Resources Basic Records Report No. 18, 1990. 80p, 1 fig, 12 tab, 9 ref.

Descriptors: *Chemical analysis, *Data collections, *Groundwater pollution, *Louisiana, *Organic compounds, *Water quality, Aroclors, Pesticides, Pollutant identification, Polychlorinated biphenyls, Synthetic compounds, Volatile organic compounds, Water analysis, Water pollution.

The US Geological Survey (USGS), in cooperation with the Louisiana Department of Transportation and Development, has collected and analyzed groundwater for synthetic organic chemicals, including pesticides since 1984. Synthetic organic chemical data collected and analyzed between October 1, 1983, and September 30, 1988 (water years 1984-88) is presented. Samples were analyzed for synthetic organic compounds in the following four classes: pesticides, aroclors (PCBs), acid-base/neutral extractable (semivolatile) organics, and volatile organics. Eleven aquifers and aquifer systems have been sampled for the presence of organic compounds in water. Ninety-three water samples from 65 wells from throughout the State were collected during water years 1984-88. In general, water quality was found to be good in the aquifers sampled, as indicated by the lack of detection of pesticides, aroclors (PCBs), semivolatile organic compounds, and volatile organic compounds. Only 39 of the approximately 8,900 individual analyses for organic compounds were at or above detection limits. These 39 analyses represented 20 organic compounds. The 20 organic compounds identified at or above detection limits were in the following classes: 7 pesticides, 3 semivolatile organic compounds, and 10 volatile organic compounds. No aroclors (PCBs) were detected. (Lantz-PTT)
W91-08183

AQUATIC TOXICITY TESTING.
Eckenfelder, Inc., Nashville, TN.
B. G. Isom.
IN: Toxicity Reduction in Industrial Effluents. Van Nostrand Reinhold, New York. 1990. p 18-34, 4 fig, 4 tab, 21 ref.

Descriptors: *Laboratory methods, *Toxicity, *Toxicology, *Wastewater analysis, *Water analysis, *Water pollution effects, Acute toxicity, Biological studies, Conductivity, Data interpretation, Dissolved oxygen, Hydrogen ion concentration, Water quality.

There are many forms and methodologies for a toxicity test, the two most commonly used today are the subchronic and the acute. The subchronic test is utilized to determine and monitor the concentration at which a discharge has an effect on survival, growth, and reproduction of test organisms. The term subchronic is used to distinguish a four to eight day test from a full chronic test which lasts one or more life cycles. The acute toxicity test is a short-term survival determination which involves exposure of a selected test organism, such as fish or water fleas, to a known dilution or concentration of sample for a specific time period, typically 48-96 hrs, but occasionally as short as 24 hrs. In aquatic toxicology, the critical measurement is concentration-response, rather than dose-response. Concentration responses are observed when testing effluent toxicity and when chemicals are mixed with water or contained in effluents; the effluent concentration or the chemical concentration is known or may be measured in the water, but the dose received by the organism is an unknown quantity. The relationship between exposure to effluents or chemical concentrations (dose) and the magnitude of observed effects (response) is best described by concentration-response curves. The four major elements of a toxicity test for a whole effluent include: obtaining a representative effluent or water sample(s); procuring or culturing a healthy test organism; applying the proper experimental design; and calculating the endpoint. It is very important to collect water quality data at the beginning, during, and at termination of toxicity tests. The dissolved oxygen and pH should be measured at the beginning and end of each 24 hr test period in one replicate at high, medium, and low concentrations and the control. Conductivity, alkalinity, and hardness should be measured in 100% effluent, receiving water, and in the controls as a minimum. (See also W91-08191) (Lantz-PTT)
W91-08193

TOXICITY IDENTIFICATION EVALUATIONS.
Eckenfelder, Inc., Nashville, TN.
W. S. Hall, and R. J. Mirenda.
IN: Toxicity Reduction in Industrial Effluents. Van Nostrand Reinhold, New York. 1990. p 35-59, 2 fig, 4 tab, 12 ref.

Descriptors: *Case studies, *Chemical analysis, *Laboratory methods, *Pollutant identification, *Toxicology, *Wastewater analysis, *Water analysis, *Water pollution effects, Invertebrates, Lethal limit, Separation techniques, Toxicity.

Inherent to nearly all toxicity reduction evaluations (TRE) is the process of conducting a toxicity identification evaluation (TIE). A TIE attempts to identify the constituent(s) or group of constituents responsible for toxicity, but does not necessarily develop a means to remove effluent toxicity. The process of conducting a TIE can be quite complex and often must consider the discharge flow characteristics, chemical make-up, variability, and relative toxicity of an effluent. An effective toxicity identification protocol must be comprehensive yet flexible. Such a program typically includes the following steps: (1) review of all historical analytical and toxicological data; (2) evaluation of effluent constituents; (3) evaluation of single streams; (4) fractionation of effluent; and (5) performance of analytical confirmation. The results of selected case studies from a variety of industrial effluent fractionations are presented and discussed. The case studies were selected to illustrate the selective use of different test species. All of the studies were carried out with invertebrates < 24 hrs old or with fish species 2-3 wks old. All of the tests were conducted at 20 C, utilizing the fractionation procedures previously described. LC50 values and 95% confidence limits were generated using the binomial procedure. All LC50 values for invertebrates are 48 hr values, and all values for fish species are 96 hr values. The results do not always clearly indicate the cause of toxicity. This is especially true for moderately or low toxicity effluents for which several treatments reduce toxicity. In these cases, the source of toxicity may be better defined by repeating fractionations until patterns develop. The case studies emphasize the need to interpret the data with a knowledge of the true mechanisms removing toxicity by a given treatment. Mechanisms of removal are not always those typically thought of for some treatments and alterations of the form of the chemical can occur during some treatments. Another observation which can be made as a result of these case studies is that trends or magnitude of change in LC50 values as a result of different treatments are valuable in determining the likely cause of toxicity. (See also W91-08191) (Lantz-PTT)
W91-08194

5B. Sources Of Pollution

ENHANCED BIODEGRADATION OF PESTICIDES IN THE ENVIRONMENT.
For primary bibliographic entry see Field 5G.
W91-07118

PESTICIDES IN THE SOIL MICROBIAL ECOSYSTEM.
DowElanco, Midland, MI. Environmental Chemistry Lab.
K. D. Racke.
IN: Enhanced Biodegradation of Pesticides in the Environment. ACS Symposium Series 426. American Chemical Society, Washington, DC. 1990. p 1-12. 83 ref.

Descriptors: *Biodegradation, *Fate of pollutants, *Microorganisms, *Path of pollutants, *Pesticides, *Soil contamination, *Soil environment, Adaptation, Agricultural chemicals, Insecticides, Literature review, Metabolism, Microbial degradation.

A review of pesticides in the soil microbial ecosystem with a discussion of properties of the soil environment, metabolic capabilities of the soil microbial community, and uses and dissipation routes of soil-applied pesticides is presented. Approximately 600 different pesticide active ingredients are registered for use in the U.S. and millions of pounds are applied globally each year. Pesticides which are applied to soil become enmeshed in the transport and degradation processes that affect all allochthonous organics added to the system. Pesticide transport processes include aerial transport from the soil to the atmosphere, and movement of dissolved or particulate-sorbed pesticides in water by leaching, convection, and diffusion. Abiotic pesticide transformation processes include photodegradation, hydrolysis, oxidation, and reduction. The microbial metabolism of pesticides has been subdivided into catabolism and 'cometabolism', the degradation of substances without utilization of the energy derived to support growth. Characteristic of microbial metabolism is the adaptability of microorganisms through mutation and induction to develop the ability to degrade compounds which initially could not be degraded or were toxic. Enhanced pesticide biodegradation has been observed in fields previously treated with the pesticide and reflects microbial adaptation for pesticide catabolism. (See also W91-07118) (MacKeen-PTT)
W91-07119

EFFECTS OF LONG-TERM PHENOXYALKANOIC ACID HERBICIDE FIELD APPLICATIONS ON THE RATE OF MICROBIAL DEGRADATION.
Agriculture Canada, Regina (Saskatchewan). Research Station.
For primary bibliographic entry see Field 5C.
W91-07120

ENHANCED CARBAMOTHIOATE HERBICIDE DEGRADATION: RESEARCH IN NEBRASKA.
Nebraska Univ., Clay Center. South Central Research and Extension Center.
F. W. Roeth, R. G. Wilson, A. R. Martin, and P. J. Shea.
IN: Enhanced Biodegradation of Pesticides in the Environment. ACS Symposium Series 426. American Chemical Society, Washington, DC. 1990. p 23-36. 8 fig, 3 tab, 32 ref.

Descriptors: *Agricultural chemicals, *Biodegradation, *Carbamate pesticides, *Fate of pollutants, *Herbicides, *Microorganisms, *Pesticides, *Soil chemistry, Adaptation, Field tests, Metabolism, Microbial degradation, Nebraska, Soil bacteria, Soil environment.

The half-life of S-ethyl dipropylcarbamothiote (EPTC) was reduced about 50% by enhanced degradation which occurred on EPTC reapplication. Enhanced carbamothioate herbicide degradation was associated with unsatisfactory shattercane control in about 60% of the fields receiving a repeat treatment of EPTC or butylate. Though diethiolate extender effectively prevented enhanced EPTC degradation, diethiolate was ineffective on reapplication. SC-0058 extender was effective in slowing EPTC degradation in soils previously treated with EPTC, EPTC plus diethyloate, and EPTC plus SC-0058. Diethiolate and SC-0058 did not increase EPTC persistence in soil without prior EPTC treatment. Reversion of EPTC degradation from an enhanced rate to a normal rate took about 18 and 30 months in western and south central Nebraska, respectively, after two annual EPTC applications. Among the common carbamothioate herbicides, EPTC, vernolate, and butylate caused enhanced degradation adn exhibited cross-adaptation; however, butylate was only partially susceptible to EPTC-enhanced degradation. Cycloate did not cause enhanced degradation nor show any susceptiblity to EPTC-enhanced degradation. The use of herbicide combinations is an effective strategy for coping sith enhanced degradation as long as both herbicides are not mutually affected and provide complementary control. The particular alternate herbicide determines the degree of effectiveness. (See also W91-07118) (Author's abstract)

W91-07121

ENHANCED BIODEGRADATION OF CARBAMOTHIOATE HERBICIDES IN SOUTH CAROLINA.
Clemson Univ., SC. Dept. of Agronomy and Soils.
H. D. Skipper.
IN: Enhanced Biodegradation of Pesticides in the Environment. ACS Symposium Series 426. American Chemical Society, Washington, DC. 1990. p 37-52. 3 fig, 7 tab, 48 ref.

Descriptors: *Agricultural chemicals, *Biodegradation, *Carbamate pesticides, *Fate of pollutants, *Herbicides, *Pesticides, *Soil chemistry, *South Carolina, Adaptation, Agricultural practices, Field tests, Metabolism, Microbial degradation, Microorganisms, Plasmids, Soil bacteria, Soil environment.

Field and laboratory studies were conducted by an interdisciplinary team to: (1) confirm enhanced biodegradation; (2) ascertain microbial cross-adaptation; (3) determine microbial population shifts with repeated use of carbamothioates; (4) delineate the role of plasmids; and (5) investigate chemical/crop rotations and inhibitors to prevent or improve problem soils. Bioassays and evolution of C-14-carbon dioxide from C-14-labelled herbicides confirmed accelerated biodegradation of butylate in soils with repeated use of butylate and cross-adaptation for S-ethyl dipropylcarbamothiote (EPTC) vernolate, and pebulate but not cycloate. Significant increases in bacteria or actinomycete populations were detected in soils treated with multiple applications of butylate, EPTC, or vernolate. Plasmids were associated with the microbial degradation of carbamothioate herbicides by a Flavobacterium sp. and a Methylomonas sp, isolated from herbicide-history soils. Chemical rotations were critical in the prevention of problem soils. A minimum of two years between applications of butylate or EPTC plus dietholate was essential to insure continued herbicidal efficacy. Enzyme inhibitors began to lose their effectiveness after three applications. (See also W91-07118) (Author's abstract)
W91-07122

ENHANCED BIODEGRADATION OF DICARBOXIMIDE FUNGICIDES IN SOIL.
Institute of Horticultural Research, Wellesbourne (England).
A. Walker, and S. J. Welch.
IN: Enhanced Biodegradation of Pesticides in the Environment. ACS Symposium Series 426. American Chemical Society, Washington, DC. 1990. p 53-67. 6 fig, 4 tab, 16 ref.

Descriptors: *Agricultural chemicals, *Biodegradation, *Fate of pollutants, *Fungicides, *Microbial degradation, *Microorganisms, *Pesticides, *Soil chemistry, Adaptation, Agricultural practices, Field tests, Metabolism, Onions, Plasmids, Soil bacteria, Soil environment.

Experiments in the mid-1970's demonstrated excellent control of white rot disease of onions with iprodione. There is increasing evidence that in commercial practice the fungicide becomes less effective with repeated use and this has been linked with enhanced degradation in the soil. In a survey involving 33 soils, a clear relationship was established between the rate of degradation and the frequency of prior application. The related compound vinclozolin is also prone to enhanced degradation and there is evidence for cross-enhancement between iprodione and vinclozolin. Rapid degrading ability can be readily transferred to slow-degrading soils by inoculation with small amounts of rapid-degrading soil, and rapid degradation can be inhibited by soil sterilization or treatment with antibiotics. Studies of the pathway of degradation have led to development of a simple colorimetric test for identification of soils with rapid-degrading ability. Mixed cultures of bacteria capable of degrading the fungicides have been isolated and there is preliminary evidence of plasmid involvement in degradation. (See also W91-07118) (Author's abstract)
W91-07123

ENHANCED BIODEGRADATION OF INSECTICIDES IN MIDWESTERN CORN SOILS.
DowElanco, Midland, MI. Environmental Chemistry Lab.
K. D. Racke, and J. R. Coats.
IN: Enhanced Biodegradation of Pesticides in the Environment. ACS Symposium Series 426. American Chemical Society, Washington, DC. 1990. p 68-81. 1 fig, 2 tab, 43 ref.

Descriptors: *Agricultural chemicals, *Biodegradation, *Fate of pollutants, *Microorganisms, *Pesticides, *Soil chemistry, Adaptation, Agricultural practices, Carbamate pesticides, Corn, Metabolism, Microbial degradation, Microbiological studies, Organophosphorus pesticides, Soil bacteria, Soil environment.

An experimental strategy for the study of enhanced degradation was developed that is based on the occurrence of observed degradation in Midwestern corn soils. The soils were collected during the fall from Iowa cornfields with known histories of insecticide use. A portion of each soil was placed in a glass jar and treated with 14C-insecticide. Insecticides used for this assay were those for which fields with some treatment histories could be identified. After each soil was moistened to 0.3 bar soil-moisture tension, glass vials containing 0.1 N NaOH were placed inside each jar to serve as CO2 traps. The jars were incubated in the dark at 25 C for one week, during which the traps were analyzed daily for trapped CO2. All soils from fields previously treated with carbofuran exhibited a much higher mineralization rate than soils from non-history fields. The shift from recalcitrant chlorinated hydrocarbons to biodegradable organophosphorus and carbamate insecticides has resulted in the failure of some compounds, notably carbofuran and isofenphos, to provide adequate pest control following repeated use. Enhanced degradation of an insecticide involves its rapid degradation by a population of soil microorganisms that has adapted to beneficially catabolize the pesticide following exposure to it or to a similar insecticide. For enhanced degradation to be thoroughly investigated studies must be carried out to demonstrate an increased rate of degradation in soils with prior insecticide exposure, to identify the rates and products of degradation in similar soils under controlled conditions, and to elucidate the microbiological mechanisms. (See also W91-07118) (Author's abstract)
W91-07124

ENHANCED DEGRADATION OF INSECTICIDES IN SOIL: FACTORS INFLUENCING THE DEVELOPMENT AND EFFECTS OF ENHANCED MICROBIAL ACTIVITY.
Agriculture Canada, London (Ontario). Research Station.
R. A. Chapman, and C. R. Harris.
IN: Enhanced Biodegradation of Pesticides in the Environment. ACS Symposium Series 426. American Chemical Society, Washington, DC. 1990. p 82-96. 16 tab, 21 ref.

Descriptors: *Agricultural chemicals, *Biodegradation, *Fate of pollutants, *Insecticides, *Microorganisms, *Pesticides, *Soil chemistry, Adaptation, Carbamate pesticides, Metabolism, Microbial degradation, Microbiological studies, Organophosphorus pesticides, Soil bacteria, Soil environment, Soil types, Soil water, Temperature effects.

Treatment of soils with pesticides at 10 ppm generated enhanced microbial activity within 6 weeks for 14 out of 18 materials tested. Increases in degradation rates ranged from 2-fold to 100-fold depending on the material and soil type. The aryl methylcarbamates and isofenphos showed the largest increases. Generally, only activity against the sulfoxide and sulfone metabolites resulted from treatment with thioether containing materials (aldicarb, phorate, terbufos, etc.). Enhanced activity to carbofuran was not generated at low temperatures (3 C), low soil moistures, or with low insecticide concentrations (<1 ppm), but once generated was relatively insensitive to low temperature, low soil moisture and further carbofuran treatment. Enhanced activity of all materials decreased in the absence of further insecticide treatment. Times required for return to baseline degradation rates ranged from about 52 wk for fensulfothion and chlorethoxyphos to >164 wk for carbofuran and isofenphos. The effectiveness of enhanced microbial populations was dependent on the form of the insecticide encountered. Granular formulations were less affected than more dispersed forms. For Furadan 15G there was a strong soil moisture dependence. The activity of enhanced microbial populations was significantly reduced by thermal or chemical biocide treatment. Cross enhancement occurred generally among the aryl methylcarbamates and among a few structurally similar organophosphorus insecticides. (See also W91-07118) (Author's abstract)
W91-07125

ENHANCED DEGRADATION OF S-ETHYL N,N-DIPROPYLCARBAMOTHIOATE IN SOIL AND BY AN ISOLATED SOIL MICROORGANISM.
Ohio Agricultural Research and Development Center, Wooster.
W. A. Dick, R. O. Ankumah, G. McClung, and N. Abou-Assaf.
IN: Enhanced Biodegradation of Pesticides in the Environment. ACS Symposium Series 426. American Chemical Society, Washington, DC. 1990. p 98-112. 7 fig, 4 tab, 31 ref. North Central Region Pesticide Impact Assessment Program Grant OH000363-SS.

Descriptors: *Biodegradation, *Fate of pollutants, *Microorganisms, *Pesticides, *Soil chemistry, Adaptation, Agricultural chemicals, Carbamate pesticides, Herbicides, Metabolism, Microbial degradation, Microbiological studies, Soil bacteria, Soil environment.

Enhanced degradation of s-ethyl N,N-dipropylcarbamothioate (EPTC) occurs in soil after repeat applications of EPTC. Studies were conducted to evaluate the mechanisms of enhanced degradation in soil and by an isolated soil microorganism (Rhodococcus sp.). Inoculation of a soil without a history of EPTC treatment with 1.0% (w/w) of a soil with enhanced EPTC degradation capabilities increased the rate of EPTC degradation in the previously untreated soil. Degradation of C-14-labelled (1-propyl position) and unlabelled EPTC by the microbial isolate yielded N-depropyl EPTC (a product of alpha-propyl hydroxylation) and EPTC-sulfoxide (sulfur oxidation). It is proposed that initial reactions of soil microorganisms involve both hydroxylation and sulfoxidation, resulting in products that are further metabolized to carbon dioxide. The hydroxylation reaction is thought to be dominant when degradation of EPTC occurs at enhanced rates. (See also W91-07118) (Author's abstract)
W91-07126

ROLE OF FUNGI AND BACTERIA IN THE ENHANCED DEGRADATION OF THE FUNGICIDE CARBENDAZIM AND THE HERBICIDE DIPHENAMID.
Agricultural Research Organization, Bet-Dagan (Israel). Volcani Center.
N. Aharonson, J. Katan, E. Avidov, and O. Yarden.
IN: Enhanced Biodegradation of Pesticides in the Environment. ACS Symposium Series 426. American Chemical Society, Washington, DC. 1990. p 113-127. 5 fig, 2 tab, 26 ref.

Descriptors: *Agricultural chemicals, *Biodegradation, *Fate of pollutants, *Fungicides, *Herbicides, *Pesticides, *Soil chemistry, Adaptation, Carbendazim, Diphenamid, Fungi, Metabolism, Microbial degradation, Microbiological studies, Microorganisms, Soil bacteria, Soil environment.

Single applications of carbendazim (MBC) or repeated applications of diphenamid conditioned the soil for enhanced degradation. Low initial doses of the pesticide or mixing a small volume of carbendazim-history soil with untreated soil sufficed to condition the entire soil volume for enhanced degradation. Soil disinfestation or treatments with fungicides such as triphenyltin acetate or tetrameth-

ylthiuram disulfide were generally effective in decreasing enhanced degradation of the two pesticides. Fungi capable of degrading MBC or diphenamid were isolated from soils with and without enhanced degradation. There were no differences in the degradation between fungi isolated from previously treated and untreated soils. Differences were found only between mixed bacterial cultures. These results, together with data about cross enhancement between some metabolites and their respective parent compounds, and the metabolism between soil and bacterial cultures, suggest that for these pesticides bacteria are the major component responsible for enhanced degradation, though fungi degraders are also present in the soil. The enzymatic reaction associated with enhanced degradation of MBC seems to involve the amino moiety that is attached to the imidazole ring. The results for diphenamid indicated that enhanced degradation is apparently linked with induction of an oxidative reaction in soil bacteria. (See also W91-07118) (Author's abstract)
W91-07127

INFLUENCE OF PESTICIDE METABOLITES ON THE DEVELOPMENT OF ENHANCED BIODEGRADATION.
Iowa State Univ., Ames. Dept. of Entomology.
L. Somasundaram, and J. R. Coats.
IN: Enhanced Biodegradation of Pesticides in the Environment. ACS Symposium Series 426. American Chemical Society, Washington, DC. 1990. p 128-140. 1 fig, 6 tab, 36 ref.

Descriptors: *Biodegradation, *Fate of pollutants, *Metabolites, *Microbial degradation, *Pesticides, *Soil chemistry, Adaptation, Agricultural chemicals, Degradation products, Metabolism, Microorganisms, Soil bacteria, Soil environment.

Pretreatment of soils with pesticide metabolites resulted in enhanced biodegradation of the parent compounds for the pesticides 2,4-dichlorophenoxyacetic acid, parathion, and isofenphos. Pretreatment of soils with selected metabolites of 2,4,5-trichlorophenoxyacetic acid, diazinon, and carbofuran did not result in increased rates of degradation of the parent compounds. Prior applications of chlorpyrifos metabolites increased the persistence of this pesticide in soils. In general, the hydrolysis products of those pesticides susceptible to enhanced degradation had lower toxicity to bacteria than the metabolites of those pesticides with little or no propensity for enhanced biodegradation. Other factors which appear to influence enhanced microbial degradation include nutrient value of the metabolite molecule, and availability of the metabolite in soils. It is concluded that pesticide degradation products are capable of conditioning soils for enhanced degradation of their parent compounds and could play an important role in the induction or inhibition of enhanced microbial degradation of some pesticides. (See also W91-07118) (MacKeen-PTT)
W91-07128

MOLECULAR GENETICS OF PESTICIDE DEGRADATION BY SOIL BACTERIA.
Agricultural Research Service, Beltsville, MD. Pesticide Degradation Lab.
J. S. Karns.
IN: Enhanced Biodegradation of Pesticides in the Environment. ACS Symposium Series 426. American Chemical Society, Washington, DC. 1990. p 141-152. 4 fig, 43 ref.

Descriptors: *Agricultural chemicals, *Biodegradation, *Fate of pollutants, *Genetics, *Microorganisms, *Pesticides, Adaptation, Literature review, Metabolism, Microbial degradation, Molecular genetics, Soil bacteria, Soil chemistry, Soil environment.

A review of the molecular genetics of pesticide degradation by soil bacteria is presented. Theoretical mechanisms by which microbial populations adapt to cause enhanced pesticide degradation include: co-metabolism, gene mutation, induction, and extra-chromosomal elements such as plasmids, transposons and bacteriophages. Several studies have indicated an important role for plasmids and transposons in enhanced pesticide degradation. The herbicide dalapon has been shown to be degraded through enzymatic dehalogenation by enzymes which were encoded on a plasmid in a chloroacetate-degrading Moraxella sp. In another study, the evolution of a Pseudomonas putida strain with enhanced degradation capabilities for dalapon involved the acquisition of dehalogenase genes on a transposon. Numerous studies have demonstrated the involvement of plasmids in the degradation of 2,4-dichlorophenoxyacetic acid. A 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) degrading Pseudomonas cepacia was shown to lose the ability to degrade 2,4,5-T at a rapid rate upon subculture in rich growth medium, a trait indicative of plasmid involvement. Plasmids have also been shown to be involved in the degradation of the organophosphate insecticide parathion. Future studies of the molecular events leading to enhanced pesticide degradation will involve the isolation of pesticide degrading microorganisms and the characterization of genes encoding pesticide degradation enzymes, combined with new techniques for isolating and examining nucleic acids from soil microorganisms. (See also W91-07118) (MacKeen-PTT)
W91-07129

RESPONSE OF MICROBIAL POPULATIONS TO CARBOFURAN IN SOILS ENHANCED FOR ITS DEGRADATION.
Purdue Univ., Lafayette, IN. Dept. of Agronomy.
R. F. Turco, and A. E. Konopka.
IN: Enhanced Biodegradation of Pesticides in the Environment. ACS Symposium Series 426. American Chemical Society, Washington, DC. 1990. p 153-166. 7 fig, 2 tab, 34 ref.

Descriptors: *Agricultural chemicals, *Biodegradation, *Carbofuran, *Fate of pollutants, *Microorganisms, *Pesticides, *Soil bacteria, Adaptation, Biomass, Metabolism, Metabolites, Microbial degradation, Populations, Soil chemistry, Soil environment.

The sizes of the microbial populations able to rapidly degrade carbofuran in soils enhanced for its degradation were enumerated by means of substrate addition and fumigation. Use of these techniques followed unsuccessful attempts to enumerate the population using plate or direct counts in the enhanced soils. Overall biomass size declined following application of carbofuran. No biomass suppression was observed in the non-enhanced soils which implies this suppression may be related to the formation of metabolites such as carbofuranphenol or methylamine. In the enhanced soils, 6% of applied pesticide was initially incorporated into biomass carbon. This contrasts with 0.87% incorporation in the non-enhanced soils. After 15 days there was complete loss of the pesticide; at this time the biomass contained 2% of the applied material. (See also W91-07118) (Author's abstract)
W91-07130

ADAPTATION OF MICROORGANISMS IN SUBSURFACE ENVIRONMENTS: SIGNIFICANCE TO PESTICIDE DEGRADATION.
Agricultural Research Service, Stoneville, MS. Southern Weed Science Lab.
For primary bibliographic entry see Field 5G.
W91-07131

MICROBIAL ADAPTATION IN AQUATIC ECOSYSTEMS.
Air Force Engineering and Services Center, Tyndall AFB, FL.
J. C. Spain.
IN: Enhanced Biodegradation of Pesticides in the Environment. ACS Symposium Series 426. American Chemical Society, Washington, DC. 1990. p 181-190. 5 fig, 1 tab, 22 ref.

Descriptors: *Aquatic environment, *Biodegradation, *Fate of pollutants, *Microorganisms, *Nitrophenols, *Pesticides, Adaptation, Agricultural chemicals, Aquatic bacteria, Metabolism, Microbial degradation, Microbiological studies.

The biodegradation of p-nitrophenol (PNP) was studied in laboratory test systems and in the field. Adaptation in freshwater microbial communities required from 3 to 10 days and biodegradation rates increased as much as one thousand-fold at PNP concentrations as low as 10 mg/L. Populations of PNP degraders increased dramatically during adaptation and no evidence of genetic change associated with adaptation was detected. Bacteria able to grow at the expense of PNP were detected in microbial communities prior to treatment with PNP. They did not begin to grow and degrade PNP until several days after initial exposure. Results indicate that accurate prediction of biodegradation rates requires a better understanding of factors that control adaptation in the environment. These include: enzyme induction, genetic changes, increases in microbial populations, predation, and nutrient limitation. (See also W91-07118) (Author's abstract)
W91-07132

EVALUATION OF SOME METHODS FOR COPING WITH ENHANCED BIODEGRADATION OF SOIL INSECTICIDES.
Illinois Natural History Survey, Champaign. Center for Economic Entomology.
A. S. Felsot, and J. J. Tollefson.
IN: Enhanced Biodegradation of Pesticides in the Environment. ACS Symposium Series 426. American Chemical Society, Washington, DC. 1990. p 192-3 fig, 9 tab, 38 ref.

Descriptors: *Agricultural chemicals, *Biodegradation, *Fate of pollutants, *Insecticides, *Pesticides, *Soil chemistry, Adaptation, Agricultural practices, Corn, Illinois, Insect control, Iowa, Management planning, Metabolism, Microbial degradation, Microorganisms, Soil bacteria, Soil environment.

Several proposed strategies for coping with enhanced biodegradation of corn rootworm insecticides have been studied in Iowa and Illinois. Operational strategies included cultivation-time treatments, suppression of adults, and insecticide rotations; a technological strategy was the use of controlled-release formulations. In 9 of 13 field experiments, carbofuran applied at cultivation prevented root damage better than when applied at planting. Root damage following adult control with carbaryl the preceding season was less than or similar to root damage following the use of soil insecticides, which suggested that corn rootworms could be controlled without use of a soil insecticide. Cultivation-time treatments and adulticiding depended on accurate timing of insecticide applications. Under laboratory conditions rotations of carbofuran with isofenphos slowed the rate of metabolism of carbofuran but did not prevent the development of enhanced biodegradation. In the field, the results of rotations of carbofuran with fonofos or terbufos were inconclusive. Multi-year treatments of fonofos resulted in enhanced biodegradation, but its rate of degradation was slowed by rotations with carbofuran or terbufos. When carbofuran was applied as a controlled-release formulation, its degradation was significantly slowed compared to the commercial sand granule; however, efficacy in the field was not improved. (See also W91-07118) (Author's abstract)
W91-07133

SYSTEMS ALLOWING CONTINUED USE OF CARBAMOTHIOATE HERBICIDES DESPITE ENHANCED BIODEGRADATION.
Wisconsin Univ.-Madison. Dept. of Agronomy.
R. G. Harvey.
IN: Enhanced Biodegradation of Pesticides in the Environment. ACS Symposium Series 426. American Chemical Society, Washington, DC. 1990. p 214-221. 7 tab, 10 ref.

Descriptors: *Agricultural chemicals, *Biodegradation, *Carbamate pesticides, *Fate of pollutants, *Herbicides, *Pesticides, *Soil chemistry, Adaptation, Agricultural practices, Management planning, Metabolism, Microbial degradation, Microorganisms, Soil bacteria, Soil environment, Weed control.

Strategies for continued use of the herbicide S-ethyl dipropyl carbamothioate (EPTC) despite enhanced biodegradation were investigated. Enhanced biodegradation of EPTC was reduced by applying the herbicide not more frequently than every other year. The extender diethiolate did not prevent enhanced EPTC degradation when the two chemicals were used repeatedly together, possibly due to a demonstrated enhancement of diethiolate biodegradation. Enhanced biodegradation of the experimental extender SC-0058 was not detected, and SC-0058 prevented enhanced EPTC biodegradation. Results suggest that by combining herbicide and crop rotation, use of chemical extenders, row cultivation, and late-season secondary herbicide applications, long-term control of weeds such as wild proso millet can be obtained. (See also W91-07118) (Author's abstract)
W91-07134

CULTURAL PRACTICES AND CHEMICALS THAT AFFECT THE PERSISTENCE OF CARBAMOTHIOATE HERBICIDES IN SOIL.
ICI Americas, Inc., Wilmington, DE.
D. C. Drost, J. E. Rodebush, and J. K. Hsu.
IN: Enhanced Biodegradation of Pesticides in the Environment. ACS Symposium Series 426. American Chemical Society, Washington, DC. 1990. p 222-239. 11 tab, 33 ref.

Descriptors: *Agricultural practices, *Biodegradation, *Carbamate pesticides, *Fate of pollutants, *Herbicides, *Microorganisms, *Pesticides, Adaptation, Agricultural chemicals, Corn, Management planning, Metabolism, Microbial degradation, Soil bacteria, Soil chemistry, Soil environment, Weed control.

Methods of reducing enhanced biodegradation of carbamothioate herbicides in soil are discussed. For S-ethyl dipropylcarbamothioate (EPTC), annual rotation has been effective in preventing the redevelopment of enhanced biodegradation problems. In addition to efficient application and incorporation, the following factors have significantly increased the weed control from EPTC, EPTC plus diethiolate, or butylate when reduced performance due to enhanced biodegradation was observed: (1) reduction of weed pressure or establishment of conditions favorable for immediate, uniform weed emergence; (2) immediate, uniform incorporation just prior to corn planting; (3) tank mixtures of carbamothioate herbicides with atrazine, cyanazine, or metolachlor; (4) rotation for more than one year to no herbicide, alachlor, cycloate, metolachlor, or trifluralin; or (5) formulations of EPTC plus R251005, an extender under evaluation by ICI Americas Inc. These cultural and chemical practices have prevented, moderated, or eliminated enhanced biodegradation in soils, and preserved the effectiveness of carbamothioate herbicides in corn cropping systems. (See also W91-07118) (MacKeen-PTT)
W91-07135

SPECTROPHOTOMETRIC METHODOLOGIES FOR PREDICTING AND STUDYING ENHANCED DEGRADATION.
Missouri Univ.-Columbia. Dept. of Entomology.
J. P. Reed, R. J. Kremer, and A. J. Keaster.
IN: Enhanced Biodegradation of Pesticides in the Environment. ACS Symposium Series 426. American Chemical Society, Washington, DC. 1990. p 240-248. 5 tab, 26 ref.

Descriptors: *Agricultural chemicals, *Analytical methods, *Biodegradation, *Microorganisms, *Pesticides, *Spectrophotometry, Adaptation, Enzymes, Herbicides, Metabolism, Microbial degradation, Soil bacteria, Soil chemistry, Soil environment.

The use of spectrophotometric methods for evaluating enhanced degradation of pesticides in soils is reviewed. Studies have suggested that activity levels of specific indigenous soil enzymes may be influenced by certain pesticides applied to soil or by their metabolites. For example, an increase in microbial urease activity has been observed in soils amended with carbofuran and ethoprop. Elevated levels of rhodanese, phosphatase, and phosphodiesterase activities from microbial isolates cultured in the presence of selected pesticides indicated a potential for biodegradation of these pesticides. Determination of the hydrolysis of fluorescein diacetate has been used as a qualitative measure of the potential ability of soil microorganisms to degrade carbamothioate herbicides in enhanced soils. Rapid detection of enhanced degradation of carbofuran in soil can be accomplished by methods involving the inhibition of acetylcholinesterase activity or by detection of the metabolite, carbofuran phenol. Degradation of isophenfos, iprodione and vinclozolin has also been estimated by measurement of their respective metabolites. It is concluded that spectrophotometric assays for potential enhanced degradation of pesticides are sensitive, simple and relatively inexpensive to perform. (See also W91-07118) (MacKeen-PTT)
W91-07136

ENHANCING BIODEGRADATION FOR DETOXIFICATION OF HERBICIDE WASTE IN SOIL.
Illinois Natural History Survey, Champaign. Center for Economic Entomology.
For primary bibliographic entry see Field 5G.
W91-07137

IMPLICATIONS OF ENHANCED BIODEGRADATION FOR THE USE AND STUDY OF PESTICIDES IN THE SOIL ENVIRONMENT.
DowElanco, Midland, MI. Environmental Chemistry Lab.
K. D. Racke.
IN: Enhanced Biodegradation of Pesticides in the Environment. ACS Symposium Series 426. American Chemical Society, Washington, DC. 1990. p 269-282. 89 ref.

Descriptors: *Agricultural chemicals, *Biodegradation, *Fate of pollutants, *Microorganisms, *Pesticides, *Soil chemistry, *Soil environment, Adaptation, Agricultural practices, Literature review, Management planning, Metabolism, Microbial degradation, Pest control, Soil bacteria.

The impact of enhanced biodegradation of pesticides was reviewed, with a discussion of major research advances and future research challenges in the field. Diverse crops such as corn, rice, sugar beets, onions, avocados, and potatoes have been affected by pest control failures caused by enhanced biodegradation of pesticides. Pesticide manufacturers have also been adversely affected by the occurrence of enhanced degradation of pesticides, due to loss of products or sales. Advances in research understanding of enhanced degradation have included: (1) documentation of accelerated degradation rates for various pesticides; (2) recognition of the different susceptibility of pesticides based upon chemical structure and availability of an accessible microbial catabolic pathway; (3) identification of compounds within a class of pesticides that are relatively resistant to enhanced biodegradation, (4) delineation of degradative cross-adaptations; and (5) characterization of pesticide-degrading microbial populations. Important areas for future research include the relationship of pesticide persistence to pest control, development of predictive tools, design of pesticides that do not induce microbial biodegradative adaptation, and use of adapted soil microorganisms for bioremediation applications. (See also W91-07118) (MacKeen-PTT)
W91-07138

PHOTOCHEMISTRY OF NITROGUANIDINE PRODUCTION WASTEWATERS.
Army Biomedical Research and Development Lab., Fort Detrick, MD.
W. D. Burrows, and C. I. Noss.
IN: Hazardous and Industrial Wastes: Proceedings of the 21st Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1989. p 269-281. 4 fig, 8 tab, 20 ref.

Descriptors: *Industrial wastes, *Nitroguanidine, *Path of pollutants, *Photolysis, *Wastewater pollution, Degradation products, Nitrogen, Toxicity, Ultraviolet light, Wastewater treatment.

Nitroguanidine, a constituent of triple-base propellant, is presently manufactured at an ammunition plant in DeSota, KS. Although the production facility was designed to operate with no wastewater discharge, it now appears that as much as 400,000 gallons/day may be generated at the full mobilization production level of 40 tons per day. The consequences of nitroguanidine photolysis were examined. Nitroguanidine is readily degraded in water by ultraviolet light and by natural sunlight. The end products of ultraviolet photolysis in unbuffered waters are guanidine, urea, cyanoguanidine and nitrite ion, with lesser quantities of nitrate ion and ammonia. Nitrosoguanidine, which is even more readily photolyzed, is an intermediate in a major pathway to guanidine. it is possible to account for 80% of the carbon from nitroguanidine and virtually all of the oxidized nitrogen. At pH 10, photolysis of nitroguanidine and nitrosoguanidine is slightly slower, but the product distribution is different. Less than 25% of the nitroguanidine carbon can be accounted for as guanidine, cyanoguanidine and urea. Gaseous nitrogen is a significant product. Photolyzed nitroguanidine has been shown by others to be much more toxic to aquatic life than nitroguanidine, but given the half-life of 1-2 days or nitroguanidine in natural waters, it is highly unlikely that wastewaters discharged to a body of moving water could present a hazard to aquatic life unless the nitroguanidine levels substantially exceeded the present NPDES (National Pollutant Discharge Elimination System) daily average limit of 25 mg/L for the ammunition plant. (See also W91-07139) (Mertz-PTT)
W91-07158

DETERMINATION OF REMEDIAL ALTERNATIVES AT A DIOXIN CONTAMINATED WASTE DISPOSAL SITE BY USE OF QUANTITATIVE RISK ASSESSMENT TECHNIQUES.
Environmental Resources Management, Inc., Exton, PA.
For primary bibliographic entry see Field 5G.
W91-07174

FLOW AND CONTAMINANT SIMULATIONS FOR A COMPLEX GROUNDWATER SYSTEM FOR THE PURPOSE OF RISK ASSESSMENT.
NUS Corp., Pittsburgh, PA.
J. Ho, and J. D. Chiou.
IN: Hazardous and Industrial Wastes: Proceedings of the 21st Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1989. p 526-546. 2 fig, 6 tab, 13 ref.

Descriptors: *Aquifer testing, *Groundwater movement, *Groundwater pollution, *Groundwater quality, *Hazardous wastes, *Industrial wastes, *Model studies, *Path of pollutants, Aquifer systems, Computer models, Groundwater management, Leaky aquifers, Waste management.

A groundwater system, influenced by an industrial hazardous waste site, contained a multi-layered, leaky aquifer. Four major water-bearing zones plus a wide clay lens were identified as shallow aquifers consisting of silty sand, clayey sand, and gravel. The clay lens is partially located between these zones. The top shallow aquifer was under water-table conditions. Two other deep zones below the shallow aquifers were composed of fractured bedrock. The area southeast of the site not only included an outcrop of bedrock but also showed the disappearance of the clay lens. The hydrogeologic study of this groundwater system indicates that the groundwater flow directions were varied among these aquifers. The existence of a river and several major production wells, not used for drinking water purposes, imposed a major boundary conditions/stress on the current groundwater system. A computer model was established that was representative of this complex system. It was able both to simulate the local groundwater flow and to evaluate the transport of contaminants in this system. A three-dimensional, finite-difference code, SWIFT III, was used to solve the generalized groundwater flow and contaminant transport equations. The stratigraphy, aquifer conditions, and boundary conditions of the system were used in the model. Calibration and verification of the

flow model indicated the appropriateness of the constructed model and the importance of groundwater recharge from local precipitation. The model also indicated the boundary effect caused by the river as well as the stress caused by the production wells. This study not only provides critical information for the required risk assessment of this particular site, but also demonstrates a methodology that is useful for other hazardous waste sites that may be similar in complexity and data status. (See also W91-07139) (Mertz-PTT)
W91-07175

UNDERGROUND STORAGE TANKS--WHAT NOW.
Pirnie (Malcolm), Inc., Newport News, VA.
For primary bibliographic entry see Field 5G.
W91-07177

NEW METHOD TO MODEL TRANSPORT AND FATE OF GASOLINE FROM LEAKING UNDERGROUND STORAGE TANKS.
New Jersey Inst. of Tech., Newark. Dept. of Civil and Environmental Engineering.
N. J. Meegoda, S. Gunasekera, and R. Hyjack.
IN: Hazardous and Industrial Wastes: Proceedings of the 21st Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1989. p 582-595. 4 fig, 2 tab, 31 ref.

Descriptors: *Fate of pollutants, *Groundwater pollution, *Model studies, *Path of pollutants, *Petroleum products, *Underground storage tanks, Chromatography, Gasoline, Mathematical models, Simulation, Water pollution sources.

Contamination of groundwater by organic and inorganic wastes has become a serious threat to subsurface water resources. Many of these waste materials are organic liquids of low water miscibility which may move convectively as a discrete liquid phase in addition to moving as a component in aqueous and gaseous phases. To mathematically model the movement of such chemicals, consideration must be given to possible simultaneous convective movement of gas, water, and nonaqueous phase liquid in systems exhibiting variable saturations of all three phases. The centrifugal modeling technique is used to study the movement of contaminants from underground storage tanks in the vadose zone to the water table and to determine the distribution of gasoline and the impact of residually contaminated soils on the groundwater quality. Data concerning separation of components from gasoline type contaminants was also examined. A site with a leaking underground storage tank was simulated in the centrifuge to find the movement of gasoline in the vadose zone. Centrifugal tests are superior to conventional mathematical models and physical models in simulating the movement of gasoline. A laboratory gasoline similar to the EPA gasoline was synthesized and was calibrated in a gas chromatograph against different percentages of carbon disulfide. The movement of gasoline was monitored at different locations of the site to obtain the gasoline concentration and the composition. Test results showed the component separation in the vadose zone, therefore fingerprinting of gasoline to identify the source seems erroneous. Test results also showed that gasoline was retained as a layer or a gasoline lens above the water table and groundwater contamination was limited to solubility constraints. (See also W91-07139) (Mertz-PTT)
W91-07179

CASE HISTORY OF A TURNKEY CLOSURE OF A PESTICIDE SITE.
Allied-Signal, Inc., Morristown, NJ.
For primary bibliographic entry see Field 5G.
W91-07181

SUPERFUND RECORD OF DECISION, KIMBERTON, PA, FIRST REMEDIAL ACTION.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
For primary bibliographic entry see Field 5G.
W91-07190

WATER QUALITY OF SELECTED TAILWATERS.
Ouachita Baptist Univ., Arkadelphia, AR. Dept. of Chemistry.
J. Nix, D. E. Hamlin-Tillman, S. L. Ashby, and M. S. Dortch.
Available from the National Technical Information Service, Springfield, VA. 22161. Technical Report W-911-2, January 1991. Final Report. 290p, 4 fig, 10 tab, 28 ref, 3 append.

Descriptors: *Canyon Lake, *Dam effects, *Lake Greeson, *Nimrod Lake, *Rough River Lake, *Tailwater, *Water quality, Ammonia, Anoxic conditions, Biochemical oxygen demand, Carbon dioxide, Dissolved oxygen, Hydrogen ion concentration, Iron, Manganese, Nitrogen, Organic carbon, Reservoirs.

This research focuses on the poor water quality associated with deep, anoxic releases from hydropower and nonhydropower reservoirs. Water quality results from the tailwaters of the Little Missouri River (Lake Greeson), Fouche La Fave River (Nimrod Lake), Rough River (Rough River Lake), and Guadalupe River (Canyon Lake) are presented and discussed. An increase in dissolved oxygen (DO) in a downstream direction was observed only at the Greeson tailwater. At the other sites, the DO generally decreased in the downstream direction. The concentration of dissolved Fe in the hypolimnion of Lake Nimrod and Rough River Lake was > 3 mg/L at the time of the study. The data from the tailwaters of these two reservoirs indicate that oxidation of Fe was occurring in the first 100-200 m of the tailwater. Although oxidation rates of Mn(II) to Mn(IV) have been observed to be very slow by numerous investigators, removal of the reduced form of Mn from all of the tailwaters studied occurred over the first 10 to 15 km of the tailwater. An inverse relationships between ammonia-N and nitrate-N was observed at Nimrod, Rough River, and Canyon Lakes. The concentration of ammonia nitrogen in the Lake Greeson tailwater was too low to make an evaluation of a trend. The ammonia which was introduced into the tailwater from the anoxic hypolimnion would be expected to exert an oxygen demand as it entered the tailwater system. A decrease in total organic carbon (TOC) in a downstream direction was observed at Lake Nimrod and Rough River Lake. The decrease was considerably more pronounced at Rough River Lake. Even though the general trend for TOC was to decline downstream, there was considerable fluctuation in these data. The results from the 10-day incubation studies which were conducted with water from Greeson, Nimrod, and Rough River Lakes indicate that some oxygen consumption was taking place in the samples. Free CO2 was observed to increase with depth at Greeson, Nimrod, and Rough River Lakes. Theoretically, an increase in pH would accompany the release of excess CO2. This pattern was observed in the Lake Greeson tailwater, but the patterns observed at Nimrod and Rough River Lakes were not clear. (Lantz-PTT)
W91-07199

CE-QUAL-RIV1: A DYNAMIC, ONE-DIMENSIONAL (LONGITUDINAL) WATER QUALITY MODEL FOR STREAMS. USER'S MANUAL.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
Available from the National Technical Information Service, Springfield, VA. 22161 as AD-A230 794. Price codes: A11 in paper copy, A02 in microfiche. Instruction Report E-90-1, November 1990. Final Report. 249p, 21 fig, 91 ref, 4 append.

Descriptors: *Computer models, *Handbooks, *Model studies, *Simulation analysis, *Streams, *Unsteady flow, *Water quality, Bacteria, Biochemical oxygen demand, Coliforms, Dissolved oxygen, Hydraulic models, Hydrodynamics, Iron, Manganese, Nitrogen compounds, Phosphates, Temperature.

A dynamic, one-dimensional (longitudinal), water quality model for unsteady flows in rivers and streams, CE-QUAL-RIV1, is presented. CE-QUAL-RIV1 is developed in two parts, hydrodynamic and water quality. Output from the hydrodynamic solution is used to drive the water quality model. The hydrodynamic code uses a four-point implicit Newton-Raphson procedure to solve the nonlinear St. Venant equation. Numerical accuracy for the advection of sharp gradients is preserved in the water quality code through the use of the explicit two-point, fourth-order accurate, Holly-Pressman scheme. Water quality constituents include: temperature, dissolved oxygen, carbonaceous biochemical oxygen demand, organic nitrogen, ammonia nitrogen, nitrate nitrogen, orthophosphate phosphorus, coliform bacteria, dissolved iron, and dissolved manganese. The effects of algae and macrophytes are also included. The model allows simulation of branched river systems with multiple hydraulic control structures, such as run-of-the-river dams, waterway locks and dams, and reregulation dams. The model was developed to simulate the transient water quality conditions associated with highly unsteady flows that can occur on regulated streams. (Author's abstract)
W91-07200

NATIONAL WATER INFORMATION SYSTEM USER'S MANUAL. VOLUME 2, CHAPTER 2, WATER-QUALITY SYSTEM.
Geological Survey, Reston, VA.
For primary bibliographic entry see Field 7C.
W91-07202

SUPERFUND RECORD OF DECISION: BURNT FLY BOG, NJ.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
For primary bibliographic entry see Field 5G.
W91-07203

SUPERFUND RECORD OF DECISION, RHINEHART TIRE FIRE, VA.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
For primary bibliographic entry see Field 5G.
W91-07205

SUPERFUND RECORD OF DECISION, SOUTH CAVALCADE STREET, TX.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
For primary bibliographic entry see Field 5G.
W91-07206

SUPERFUND RECORD OF DECISION, WAUSAU WATER SUPPLY, WI.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
For primary bibliographic entry see Field 5G.
W91-07207

NUTRIENT LOADING STATUS OF THE CONESTOGA RIVER BASIN, 1985-1989.
Susquehanna River Basin Commission, Harrisburg, PA. Resource Quality Management and Protection Div.
A. N. Ott.
Susquehanna River Basin Commission Publication No. 133, September 1990. 11 p, 4 fig, 3 tab.

Descriptors: *Conestoga River Basin, *Nutrients, *Water quality, Ammonia, Nitrogen, Nonpoint pollution sources, Phosphorus, Suspended sediments.

Nutrient monitoring of the Conestoga River has indicated no change in the nitrogen loading for the period 1985-1989, but shows a slight decrease in the phosphorus load for 1988, and a significant decrease for 1989. Records from the Lancaster sewage treatment plant (STP) show a decreased phosphorus concentration in their effluent midway through 1988, and an even lower concentration throughout 1989. While they have significantly decreased their ammonia concentration during the same period, the nitrate concentration has concurrently increased. Subtraction of the point source STP nutrient load from the measured basin load provides an estimate of the nonpoint nutrient load.

Evaluation of this phosphorus load with water discharge shows no change in loading from 1985-1988, but shows a definite load decrease in 1989. This decrease in 1989 phosphorus nonpoint source load is shown to be coincidental with the lower than normal suspended sediment load in 1989. This study indicates that long-term monitoring data can be used to detect changes in small tributary watersheds. However, interpretation of the data must be coupled with a knowledge of the changing conditions within the watershed. (Lantz-PTT)
W91-07209

SUPERFUND RECORD OF DECISION: ROCKY HILL, NJ.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
For primary bibliographic entry see Field 5G.
W91-07218

WATER QUALITY OF INTERSTATE STREAMS IN THE SUSQUEHANNA RIVER BASIN. MONITORING REPORT 3: WATER YEAR 1989.
Susquehanna River Basin Commission, Harrisburg, PA. Resource Quality Management and Protection Div.
C. P. McMorran, and S. W. Bollinger.
Susquehanna River Basin Commission Publication No. 131, April 1990. (October 1988--September 1989). 104p, 6 fig, 40 tab, 4 ref, 2 append.

Descriptors: *Interstate rivers, *Monitoring, *Susquehanna River Basin, *Water quality, Aluminum, Benthic fauna, Chemung River, Cowanesque River, Deer Creek, Macroinvertebrates, Maryland, Octoraro Creek, Pennsylvania, Scott Creek, Surface water, Tioga River, Troups Creek, Trowbridge Creek, Water pollution effects.

Water samples were collected from twelve stations on interstate streams in November 1988, and February, May and August 1989. Water samples were collected from 23 stations on other interstate streams. Benthic macroinvertebrates were sampled from each station in July and August 1989. The data collected is used: (1) to assess compliance with water quality standards; (2) to assess impacts on water quality; (3) to characterize ambient and seasonal stream quality; and (4) for future trend assessment. Scott Creek is the only interstate stream having poor water quality. Untreated sewage discharges from Cardiff, Maryland, impairs water quality and biological conditions. The Cowanesque River exhibits biological impacts due to Cowanesque Lake, but impacts on water quality were minor. The Chemung River showed slight to moderate impairment of macroinvertebrates and water quality due to wastewater discharges from Elmira. Octoraro Creek and Tioga River showed moderate macroinvertebrate impairment coincident with elevated concentrations of some chemical parameters. Elevated chemical concentrations were observed in the Susquehanna River at Sayre and Cayuta Creek; however, no macroinvertebrate impairment was observed. Falling Branch Deer Creek, Big Branch Deer Creek, Troups Creek and Trowbridge Creek showed varying degrees of macroinvertebrate impairment, but no specific causes were indicated by water quality data. Most interstate streams have good water quality. Only 30 out of 1,460 observations exceeded water quality standards. Aluminum most commonly exceeded standards. (Author's abstract)
W91-07219

HERBICIDES IN WATER: ECONOMICS OR ENVIRONMENT.
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
For primary bibliographic entry see Field 4A.
W91-07220

IMPACT OF RESIDENTIAL URBAN AREAS ON GROUNDWATER QUALITY: SWAN COASTAL PLAIN, WESTERN AUSTRALIA.
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
For primary bibliographic entry see Field 4C.
W91-07224

BIBLIOGRAPHY OF ATRAZINE AND ITS SIMPLE DEGRADATION PRODUCTS IN THE ENVIRONMENT.
Geological Survey, St. Paul, MN. Water Resources Div.
For primary bibliographic entry see Field 10C.
W91-07225

ACIDIC PRECIPITATION. VOLUME 4: SOILS, AQUATIC PROCESSES, AND LAKE ACIDIFICATION.
Advances in Environmental Science. Springer-Verlag, New York. 1990. 293 p. Edited by S. A. Norton, S. E. Lindberg, and A. L. Page.

Descriptors: *Acid neutralizing capacity, *Acid rain, *Acidification, *Aquatic environment, *Path of pollutants, *Soil chemistry, Acid lakes, Aluminum, Canada, Chemical speciation, Diatoms, Geochemistry, Heavy metals, Hydrogen ion concentration, Lake acidification, Land restoration, Paleohydrology, Snowpack, Soil contamination, Sulfates.

Acidic precipitation and its effects have been the focus of intense research for over two decades. Recently, research has focused on a greater understanding of dose-response relationships between atmospheric loading of acidifying material and lake acidity. This volume of the subseries Acidic Precipitation emphasizes acid neutralizing processes and the capacity of terrestrial and aquatic systems to assimilate acidifying substances and, conversely, the ability of systems to recover after acid loading diminishes. Papers presented are titled: Soil Reaction and Acidic Deposition; Acidic Sulfate Soils; Aluminum Speciation--Methodology and Applications; Snowpack Storage of Pollutants, Release during Melting, and Impact on Receiving Waters; Buffering of pH Depressions by Sediments in Streams and Lakes; Mitigation of Acidic Conditions in Lakes and Streams; Recovery of Acidified and Metal-Contaminated Lakes in Canada; and, Paleoecological Analyses of Lake Acidification Trends in North America and Europe Using Diatoms and Chrysophytes. (See W91-07228 thru W91-07235) (Lantz-PTT)
W91-07227

SOIL REACTION AND ACIDIC DEPOSITION.
Colorado State Univ., Fort Collins. Dept. of Agronomy.
J. O. Reuss, and P. M. Walthall.
IN: Acidic Precipitation. Volume 4: Soils, Aquatic Processes, and Lake Acidification. Advances in Environmental Science. Springer-Verlag, New York. 1990. p 1-33, 9 fig, 2 tab, 73 ref. Colorado Agricultural Experiment Station Project No. 6232, and EPA Agreement No. CR812319 to Colorado State University.

Descriptors: *Acid rain, *Acidic soils, *Chemical reactions, *Path of pollutants, *Soil chemistry, Acidification, Aluminum, Anions, Buffering, Cations, Geochemistry, Hydrogen ion concentration.

The major chemical processes by which acidic deposition interacts with soils are discussed, with a focus on forest soils. The effects of acidic deposition on soils used for production of food and fiber are generally small compared to effects of agricultural practices such as nitrogen fertilizer applications and liming. Buffering mechanisms considered include aluminum buffering, silicate mineral buffering, cation exchange, organic buffering, and the effect of anion immobilization processes such as nitrate uptake and sulfate adsorption. The effects of acidic inputs on capacity factors such as exchange acidity, exchangeable base content, and sulfate adsorption capacity are considered, as are related natural processes such as acidification due to the accumulation of bases in biomass. Particular attention is paid to intensity effects, such as the effect of increased concentration of anions associated with strong acids on the chemical composition of the soil solution, as they are likely to be highly nonlinear with respect to the capacity factors. These include pH, aluminum mobilization, and loss of alkalinity in the soil solution, which in turn may result in acidification of drainage waters. Due to the variety and complexity of processes, results of field and laboratory experiments are likely to be highly variable. A few examples are discussed in relation to the mechanisms that appear to be controlling the response in each case. (See also W91-07227) (Author's abstract)
W91-07228

ACIDIC SULFATE SOILS.
Department of Agriculture, Bangkok (Thailand). Div. of Soils.
J. Prasittikhet, and R. P. Gambrell.
IN: Acidic Precipitation. Volume 4: Soils, Aquatic Processes, and Lake Acidification. Advances in Environmental Science. Springer-Verlag, New York. 1990. p 35-62, 1 tab, 86 ref.

Descriptors: *Acid rain, *Acid rain effects, *Acidic soils, *Geochemistry, *Path of pollutants, *Sulfates, Aluminum, Buffering, Carbon dioxide, Chemical reactions, Fate of pollutants, Iron, Soil chemistry, Sulfuric acid.

Acidic sulfate soils are formed from potential acidic sulfate soils that are characterized by the accumulation of pyrite (FeS2). Upon drainage of these soils, the pyrite oxidizes to produce sulfuric acid and hence acidic sulfate soils. The acid formed commonly decreases the soil's pH to < 4, and sometimes as low as 2. The acid produced has a major effect on chemical and microbial processes in soils. Substances detrimental to plant growth, such as Al(3+), Fe(2+), H2S, and CO2 are often generated in amounts toxic to plant growth. In acidic sulfate soils, the potential for very acidic soil conditions to develop results from natural processes. Often, however, cultural disturbances of these potential acidic sulfate soils, such as drainage for agricultural purposes or other reasons, cause the chemical and microbial processes to occur worldwide in most climatic zones, but are found primarily in tropical regions. Most acidic sulfate soils are found in coastal areas at low elevations, where they develop from pyrite-containing marine sediments. These soils are a major problem because of their harmful effect on crop production, and because of the large areas affected in regions of the world where additional food production is especially important. Acidic sulfate soils are generally far more acidic than can be generated by even severe acidic precipitation problems. Acidic precipitation is unlikely to adversely affect either acidic sulfate soils or, for different reasons, potential acidic sulfate soils. Knowledge of acidic sulfate soil chemistry, the problems experienced with such soils, and feasible management practices to mitigate some of the problems, should provide information on the type and direction of chemical changes that may occur in poorly buffered soils in other regions of the world as a result of acidic precipitation. (See also W91-07227) (Author's abstract)
W91-07229

ALUMINUM SPECIATION: METHODOLOGY AND APPLICATIONS.
Savannah River Ecology Lab., Aiken, SC. Div. of Biogeochemistry.
P. M. Bertsch.
IN: Acidic Precipitation. Volume 4: Soils, Aquatic Processes, and Lake Acidification. Advances in Environmental Science. Springer-Verlag, New York. 1990. p 63-105, 10 fig, 2 tab, 190 ref. DOE Contract DE-AC09-765R00-819.

Descriptors: *Acid rain, *Acid rain effects, *Aluminum, *Chemical speciation, *Path of pollutants, Acidification, Aquatic environment, Bioavailability, Environmental chemistry, Fate of pollutants, Geochemistry, Literature review, Toxicity.

There exists ample evidence to suggest that chemical speciation regulates Al mobility in the environment, and its bioavailability and toxicity to many aquatic organisms and plant species. It is difficult to recommend a specific speciation method because the choice depends largely on the specific

application. In order to elucidate general trends, for example, a method that generally separates inorganically and organically bound Al and colloidal solid-phase Al components seems to be adequate for many investigations. Although Al associated with specific organic components appears to be very important in describing the complex behavior of Al in watersheds, most currently used methods do not discriminate between different classes of organic Al complexes. Likewise, toxicological investigations continue to be concerned with differentiating the toxicity of specific inorganic and organic Al complexes, and currently available methods and approaches generally are inadequate for providing such detailed microscopic molecular information. There has been significant, although not quite convergent, progress made in understanding the differential toxicity of Al to both terrestrial and aquatic organisms and in describing the complex behavior of Al in acidified watersheds by the utilization of existing Al speciation techniques. It is increasingly clear, however, that the specific elucidation of the underlying mechanisms regulating toxicity, or of the complex processes involved in the biogeochemical cycling of Al in forested ecosystems, will require greater refinement of Al speciation methods, particularly with respect to the organic Al fractions. Furthermore, it is becoming increasingly established that important reactions involving the mobilization and transport of Al occur during episodic events, where nonequilibrium processes may be quite important. Thus, the rates and mechanisms controlling Al release and Al species transformations are very important yet poorly understood processes. Further development and refinement of Al speciation techniques will also be required if these important controls on the biogeochemical cycling of Al as influenced by acidic deposition are to be better defined. (See also W91-07227) (Lantz-PTT)
W91-07230

SNOWPACK STORAGE OF POLLUTANTS, RELEASE DURING MELTING, AND IMPACT ON RECEIVING WATERS.
National Water Research Inst., Burlington (Ontario). Rivers Research Branch.
D. S. Jeffries.
IN: Acidic Precipitation. Volume 4: Soils, Aquatic Processes, and Lake Acidification. Advances in Environmental Science. Springer-Verlag, New York. 1990. p 107-132, 3 fig, 4 tab, 148 ref.

Descriptors: *Acid rain, *Acid rain effects, *Acidification, *Aluminum, *Path of pollutants, *Snowmelt, *Snowpack, *Water pollution effects, Acid neutralizing capacity, Air pollution, Hydrogen ion concentration, Literature review, Nitrates, Pesticides, Polychlorinated biphenyls, Receiving waters, Sulfates.

Information on the snowpack content of major ions, trace metals, and organic contaminants (pesticides and total PCBs) is discussed in this review paper. Although several limitations exist, regional snowpack surveys have been successfully used to delineate spatial trends in acidic deposition. In contrast to the annual anionic predominance of SO4(2-) in atmospheric deposition, NO3(-) is often of a similar magnitude or even greater than SO4(2-) in the snowpack in locations affected by acidic deposition. Trace metal concentrations are generally greater than tenfold higher at European and North American regional locations, than in Arctic or Antarctic 'background' sites. The dry deposited component of the total snowpack pollutant load is generally less significant (1% to 45%) than the wet-deposited component, although there is much variability among chemical parameters and locations. There is conflicting evidence on the premelt stability of snowpacks: stability is clearly governed by many factors, and the occurrence of unfrozen underlying soils may be very important. The net radiative energy flux is primarily responsible for melting. Delivery of meltwater is often greatly complicated by the snowpack mesostructure; ice layers and the development of within-pack pipe flow can make modeling of this process very difficult. Rain-on-snow events can be very important both hydrologically and chemically. Fractionation of the pollutants during normal snowpack metamorphosis gives early meltwater ion and metal concentrations that are five-fold to ten-fold greater than those in the parent snow. Major ions are lost from the snowpack at differing rates during melting, a process known as preferential elution. Springtime reductions in pH, acid-neutralizing capacity, and base cations observed in surface waters occur due to both simple dilution and the differential release of snowpack pollutants. In contrast, lake and stream concentrations of Al and NO3(-) typically increase, although the behavior of the latter is variable from location to location. Concentrations of SO4(2-) remain comparatively constant, an observation attributed to rapid exchange of this ion in the soil environment. (See also W91-07227) (Author's abstract)
W91-07231

BUFFERING OF PH DEPRESSIONS BY SEDIMENTS IN STREAMS AND LAKES.
Maine Univ., Orono. Dept. of Geological Sciences.
For primary bibliographic entry see Field 2K.
W91-07232

MITIGATION OF ACIDIC CONDITIONS IN LAKES AND STREAMS.
Electric Power Research Inst., Palo Alto, CA.
For primary bibliographic entry see Field 5G.
W91-07233

RECOVERY OF ACIDIFIED AND METAL-CONTAMINATED LAKES IN CANADA.
Toronto Univ. (Ontario). Inst. for Environmental Studies.
For primary bibliographic entry see Field 5G.
W91-07234

PALEOECOLOGICAL ANALYSIS OF LAKE ACIDIFICATION TRENDS IN NORTH AMERICA AND EUROPE USING DIATOMS AND CHRYSOPHYTES.
Indiana Univ. at Bloomington. Dept. of Biology.
For primary bibliographic entry see Field 5C.
W91-07235

HILLSLOPE EROSION AT THE MAXEY FLATS RADIOACTIVE WASTE DISPOSAL SITE, NORTHEASTERN KENTUCKY.
Geological Survey, Louisville, KY. Water Resources Div.
For primary bibliographic entry see Field 2J.
W91-07239

CHESAPEAKE BAY NONPOINT SOURCE PROGRAMS.
Environmental Protection Agency, Annapolis, MD. Chesapeake Bay Liaison Office.
For primary bibliographic entry see Field 5G.
W91-07249

CODORUS CREEK PRIORITY WATER BODY SURVEY REPORT: WATER QUALITY STANDARDS REVIEW.
Susquehanna River Basin Commission, Harrisburg, PA. Resource Quality Management and Protection Div.
For primary bibliographic entry see Field 5G.
W91-07250

PARAMETER ESTIMATION FROM ARTIFICIAL TRACER EXPERIMENTS.
Gesellschaft fuer Strahlen- und Umweltforschung m.b.H. Muenchen, Neuherberg (Germany, F.R.). Inst. fuer Hydrologie.
For primary bibliographic entry see Field 2F.
W91-07259

APPLICATION OF AN AUTOMATIC CALIBRATION TECHNIQUE TO MODELLING AN ALLUVIAL AQUIFER.
Universidad Politecnica de Cataluna, Barcelona (Spain). Escuela Tecnica Superior de Ingenieros de Caminos, Canales y Puertos.
For primary bibliographic entry see Field 2F.
W91-07262

MARCHAL: A THREE-DIMENSIONAL MODEL FOR GROUNDWATER FLOW AND QUALITY MODELLING.
Strasbourg-1 Univ. (France). Inst. de Mechanique des Fluides.
For primary bibliographic entry see Field 2B.
W91-07266

PERCOLATION AND RANDOM WALK MODELS FOR SIMULATING DISPERSION PHENOMENA IN FRACTURE NETWORKS.
Ministry of Agriculture, Tel-Aviv (Israel). Water Commission.
B. Berkowitz, and C. Braester.
IN: ModelCARE 90: Calibration and Reliability in Groundwater Modelling. IAHS Publication No. 195. International Association of Hydrological Sciences, Washington, DC. 1990. p 205-210. 1 fig, 1 tab, 11 ref.

Descriptors: *Dispersion, *Flow models, *Fracture permeability, *Geological fractures, *Groundwater transport, *Mass transport, *Model studies, *Path of pollutants, *Percolation, *Random walk method, *Solute transport, Calibrations, Computer programs, Data interpretation, Flow equations, Groundwater movement, Mathematical studies, Monte Carlo method, Simulation analysis.

Spreading of contaminants in fracture networks, not amenable to description by the continuum approach, was investigated using a two-dimensional irregular fracture network. The problem was solved by using the equations of flow, a random walk model and percolation theory. A two-dimensional irregular fracture network, consisting of fractures of equal length and different apertures, was obtained from a regular orthogonal network from which some of the fractures were removed. The fracture apertures were drawn randomly from a lognormal distribution. The random walk was directed by an exact solution of flow through the network, and Monte Carlo simulation were performed to track particles through the fracture system. The scaling relationships obtained here were found to be in excellent agreement with the most recent predictions of percolation theory. It is concluded that the proposed random walk model, and percolation theory, are capable of providing quantitative relationships describing dispersion phenomena in fracture networks. (See also W91-07253) (Author's abstract)
W91-07273

PREDICTION OF CADMIUM ACCUMULATION IN A HETEROGENEOUS SOIL USING A SCALED SORPTION MODEL.
Agricultural Univ., Wageningen (Netherlands). Dept. of Soil Science and Plant Nutrition.
A. E. Boekhold, S. E. A. T. M. Van der Zee, and F. A. M. De Haan.
IN: ModelCARE 90: Calibration and Reliability in Groundwater Modelling. IAHS Publication No. 195. International Association of Hydrological Sciences, Washington, DC. 1990. p 211-220. 3 fig, 2 tab, 20 ref.

Descriptors: *Adsorption kinetics, *Cadmium, *Hydrogen ion concentration, *Mass transport, *Model studies, *Organic carbon, *Path of pollutants, *Soil contamination, *Soil water, *Solute transport, Accumulation, Calibrations, Data interpretation, Heterogeneity, Prediction, Soil chemistry, Soil solution, Sorption, Spatial distribution.

A transport model was developed that includes the most relevant processes for cadmium accumulation in the soil and accounts explicitly for the effects of pH and organic carbon content. Sorption parameters for the model were estimated using batch experiments with soil from an arable field. With these parameter values, model predictions of solute breakthrough were in good agreement with measurements. With the validated sorption model, cadmium contents along a transect in the field were predicted using measured values of pH, organic carbon content, and cadmium concentration in soil solution. Although spatial variability of these parameters is distinct and not identical to the spatial variability of the total cadmium content of the soil,

model predictions showed good agreement with the observed spatial pattern. Spatial variability of pH and organic matter content is an important factor that invokes heterogeneity of cadmium content in this soil. (See also W91-07253) (Author's abstract)
W91-07274

APPROACH TO MODEL TRANSPORT OF CONTAMINANTS INCLUDING GEOCHEMICAL PROCESSES: DEPENDENCE OF SORPTION COEFFICIENTS ON GEOCHEMICAL SURROUNDING.
Technische Univ. Berlin (Germany, F.R.). Inst. fuer Wassergefaehrdende Stoffe.
E. Butow, E. Holzbecher, and V. Koss.
IN: ModelCARE 90: Calibration and Reliability in Groundwater Modelling. IAHS Publication No. 195. International Association of Hydrological Sciences, Washington, DC. 1990. p 221-229. 7 fig, 2 tab, 12 ref.

Descriptors: *Adsorption kinetics, *Geochemistry, *Groundwater chemistry, *Groundwater movement, *Groundwater pollution, *Hydrologic models, *Model studies, *Path of pollutants, *Pollutant transport, *Sorption, Calibrations, Carbonates, Cation exchange, Chemical interactions, Chlorides, Computer models, Computer programs, Contamination, Cyanide, Data interpretation, Fluorides, Germany, Hydrogen ion concentration, Mass transport, Nickel, Phosphates, Sodium, Solute transport, Strontium, Sulfates, Uranium.

Transport modeling endeavors to predict the behavior of contaminants in groundwater and ascertain the severity of contamination. Transport models combine computer programs that calculate groundwater flow and the geochemical behavior of the contaminants. Conventional transport programs take the geochemical behavior of contaminants into account by the use of elemental sorption coefficients. The influence of fluoride, chloride, cyanide, carbonate, sulfate, and phosphate concentrations and of pH on the elemental sorption coefficients of sodium, strontium, nickel, and uranium were evaluated in an oxidizing sandy sediment-groundwater system. Geochemical data were obtained from 1600 groundwater analyses from Northern Germany. Sorption coefficients were calculated according to a simple surface complexation model using the geochemical code MINEQL. The results of the investigation revealed that anionic contamination had no influence on sodium sorption. While strontium sorption decreased only at extremely high sulfate concentrations, nickel sorption showed a strong dependence on cyanide and carbonate concentrations and pH. Uranium sorption decreased with increasing pH. The dependence of uranium sorption on pH was calculated and compared to experimental results which revealed that the calculated and experimental sorption ratios agreed within 9% of the total metal concentration. Sorption of all metal ions increased with increasing cation exchange capacity of the sediment. (See also W91-07253) (Korn-PTT)
W91-07275

EXPERIMENTAL STUDY OF COUPLED FLOW AND MASS TRANSPORT: A MODEL VALIDATION EXERCISE.
Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands).
S. M. Hassanizadeh.
IN: ModelCARE 90: Calibration and Reliability in Groundwater Modelling. IAHS Publication No. 195. International Association of Hydrological Sciences, Washington, DC. 1990. p 241-250. 7 fig, 12 ref.

Descriptors: *Groundwater movement, *Mass transport, *Mathematical models, *Model studies, *Path of pollutants, *Pollutant transport, *Radioactive waste disposal, *Soil contamination, Brines, Calibrations, Computer models, Darcys law, Data interpretation, Dispersion, Experimental data, Experimental design, Ficks Law, Flow equations, Flow models, Mathematical analysis, Mathematical equations, Mathematical studies, Model testing.

An integral part of the safety assessment of nuclear waste disposal is the study of nuclide transport in the geosphere. This requires the use of mathematical models to achieve an understanding of the various processes which take place within soil formations. A candidate type of formation for hosting a waste repository is a salt rock. Groundwater in the aquifers surrounding and overlying salt formations often contain a high concentration of salt. This must be taken into account in studies of nuclide transport. Laboratory experiments were conducted on the dispersion of salt water in a porous medium in order to study the applicability of Darcy's and Fick's laws in high-concentration solutions. In the experiments, a low-concentration salt solution (1-3 g/l), which initially filled the column, was displaced with a higher concentrated solution (3-280 g/l). The salt mass fraction was monitored as a function of time using an array of 16 electrodes installed in five rows. The computer package SPRINT was employed for simulating the experiments. The results of the investigation revealed that, for low-concentration gradient experiments, the use of classical Darcy's and Fick's laws showed very good agreement between calculated and experimental results. However, appreciable differences were found for high-concentration gradient situations. After checking a number of plausible modifications to Fick's law, it appeared that a nonlinear relationship for the dispersive mass flux provided a satisfactory agreement between calculated and experimental results. (See also W91-07253) (Korn-PTT)
W91-07277

TRANSPORT AND STORAGE PHENOMENA IN A FRACTURE MATRIX SYSTEM: EXPERIMENTAL INVESTIGATIONS AND NUMERICAL MODELLING.
Hanover Univ. (Germany, F.R.). Inst. fuer Wasserwirtschaft, Hydrologie und Landwirtschaftlichen Wasserbau.
For primary bibliographic entry see Field 2F.
W91-07279

VAPOUR TRANSPORT OF ORGANIC COMPOUNDS: SIMULATION OF FIELD EXPERIMENTS AND MODEL VALIDATION.
Waterloo Univ. (Ontario). Inst. for Ground Water Research.
C. A. Mendoza, E. O. Frind, and B. M. Hughes.
IN: ModelCARE 90: Calibration and Reliability in Groundwater Modelling. IAHS Publication No. 195. International Association of Hydrological Sciences, Washington, DC. 1990. p 331-340. 5 fig, 1 tab, 14 ref.

Descriptors: *Aeration zone, *Calibrations, *Model studies, *Model testing, *Organic solvents, *Path of pollutants, *Simulation, Advection, Case studies, Chlorinated hydrocarbons, Data interpretation, Density, Dispersion, Field tests, Finite element method, Groundwater pollution, Mathematical studies, Multiphase flow, Numerical analysis, Organic carbon, Organic compounds, Solvents, Sorption, Temperature effects, Trichloroethylene, Vapor transport, Water pollution sources.

Efforts are underway to examine various pathways by which chlorinated solvents find their way into groundwater. One possible pathway is through vapor transport from a residual solvent source in the unsaturated zone. Several models have been proposed to simulate vapor transport in the unsaturated zone. A vapor transport model that incorporates the effects of temperature-dependent and density-dependent parameters on vapor flow was investigated. An axisymmetric finite-element model was used to simulate the advective-dispersive transport of trichloroethylene (TCE) vapors from a residual source in the unsaturated zone. The data was obtained from two detailed field experiments in which a mixture of sand and TCE served as the residual solvent source. The results of the investigation revealed that the numerical model correctly represented the process of vapor transport in the unsaturated zone. The model has been verified to the extent possible by comparison to a semi-analytical model, and validated by comparisons to data obtained from controlled field experiments. In view of the various unavoidable sources of error, the agreement was very good. Also the model results appeared to be virtually free of numerical dispersion. Vapor transport in the unsaturated zone was found to be highly sensitive not only with respect to temperature, but also with respect to the choice of the functional representation of the temperature-dependent parameters. The carbon content of the organic-rich soil layers also exerted a controlling influence by sorbing significant amounts of vapor mass. (See also W91-07253) (Korn-PTT)
W91-07286

PERSPECTIVE ON NON-UNIQUENESS IN THREE-DIMENSIONAL TRANSPORT SIMULATIONS OF BIODEGRADING ORGANIC CONTAMINANTS.
Waterloo Univ. (Ontario). Inst. for Ground Water Research.
J. W. Molson, and E. O. Frind.
IN: ModelCARE 90: Calibration and Reliability in Groundwater Modelling. IAHS Publication No. 195. International Association of Hydrological Sciences, Washington, DC. 1990. p 341-350. 6 fig, 1 tab, 12 ref.

Descriptors: *Biodegradation, *Fate of pollutants, *Groundwater pollution, *Groundwater transport, *Leaching, *Mass transport, *Model studies, *Organic pollutants, *Path of pollutants, *Pollutant transport, Advection, Aerobic conditions, Benzene, Calibrations, Canada, Case studies, Data interpretation, Dispersion, Field tests, Finite element method, Landfills, Mathematical studies, Plumes, Simulation, Three-dimensional model.

Groundwater contamination from municipal and industrial landfills continues to be a significant environmental problem in Canada. Numerical simulation models are often used to predict the behavior of organic contaminants in groundwater. However, it is known that solutions to most numerical problems of field-scale, non-reactive mass transport are non-unique. Recently, significant advances have been made in computational techniques which allow the inclusion of multiple, reactive species and coupled systems within fully three-dimensional domains. A plume of organic contamination at a landfill site near Ottawa was examined by using a three-dimensional numerical simulation model. The simulation used a finite element model for advective-dispersive mass transport with aerobic biodegradation of organic contaminants. The distribution and concentration levels of benzene were used as a reference for model calibration. The results of the investigation revealed that organic biodegradation increased the degrees of freedom above those known to exist in the calibration of linear (non-reactive) mass transport models. Therefore, biodegradation parameters must be determined independently of field plume measurements in order to allow meaningful predictions of plume behavior. The study also showed that non-uniqueness could exist not only with respect to the magnitude of the parameters, but also with respect to the existence of physical and biochemical processes in a given situation. The possibility of non-uniqueness should, therefore, be considered when assessing the accuracy of predictive simulations based on limited field data. (See also W91-07253) (Korn-PTT)
W91-07287

REEVALUATION OF LARGE-SCALE DISPERSIVITIES FOR A WASTE CHLORIDE PLUME: EFFECTS OF TRANSIENT FLOW.
Geological Survey, Reston, VA.
D. J. Goode, and L. F. Konikow.
IN: ModelCARE 90: Calibration and Reliability in Groundwater Modelling. IAHS Publication No. 195. International Association of Hydrological Sciences, Washington, DC. 1990. p 417-426. 4 fig, 1 tab, 12 ref.

Descriptors: *Chlorides, *Dispersivity, *Flow models, *Groundwater movement, *Groundwater pollution, *Hydrologic models, *Model studies, *Model testing, *Path of pollutants, *Plumes, Aquifers, Basalts, Calibrations, Data interpretation, Dispersion, Error analysis, Field tests, Geologic fractures, Heterogeneity, Idaho National Engineering Laboratory, Mathematical analysis, Numerical

analysis, Recharge, Sensitivity analysis, Simulation, Solute transport, Spatial distribution, Statistical analysis, Transmissivity, Uncertainty, Velocity.

The effects of transient groundwater flow on dispersion of a waste chloride plume were studied in the basaltic aquifer beneath the Idaho National Engineering Laboratory. In an early application of numerical modelling techniques to the two-dimensional simulation of field-scale plumes, previous investigations identified longitudinal and transverse dispersivities using an independently calibrated steady-state flow model and matching contours of observed and simulated concentrations. The unusual result of calibrated transverse dispersivity (140 m) being significantly larger than longitudinal dispersivity (90 m) has been attributed to spatial heterogeneity, the fractured nature of the aquifer, and to the use of a two-dimensional model. New calibrations of the solute-transport model were performed on point concentration observations using a flow model incorporating transient recharge conditions that cause significant fluctuations in velocity. Under transient flow conditions, the lowest calibration errors were achieved with significantly larger dispersivities than previously hypothesized, and with the longitudinal component larger than the transverse component. Unfortunately, the sensitivity of the model calibration error to dispersivity was low. Incorporating transient flow in this two dimensional porous-media model did not significantly improve understanding of the processes controlling chloride transport at this site. (See also W91-07253) (Author's abstract)
W91-07294

STOCHASTIC ASPECTS OF NONPOINT NITRATE LEACHING FROM AGRICULTURAL FIELDS.
Hohenheim Univ., Stuttgart (Germany, F.R.). Inst. fuer Bodenkunde und Standortslehre.
B. Huwe.
IN: ModelCARE 90: Calibration and Reliability in Groundwater Modelling. IAHS Publication No. 195. International Association of Hydrological Sciences, Washington, DC. 1990. p 439-446. 4 fig, 18 ref. German Research Foundation (Deutsche Forschungsgemeinscaft) Grant No. Ko 528/11-4.

Descriptors: *Agricultural runoff, *Groundwater transport, *Leaching, *Model studies, *Model testing, *Nitrates, *Nonpoint pollution sources, *Path of pollutants, *Soil water, *Stochastic process, Calibrations, Data interpretation, Differential equations, Field tests, Finite difference methods, Germany, Groundwater management, Hydraulic conductivity, Mathematical analysis, Mathematical equations, Mathematical studies, Monte Carlo method, Sensitivity analysis, Simulation, Soil management, Standard deviation, Uncertainty, Variation coefficient.

Deterministic simulation models that describe the behavior of nitrogen in agricultural soils can provide a useful tool in soil management and groundwater protection problems. However, the spatial variability of the majority of the soil and atmospheric parameters used in such models restricts their use at the scale of entire agricultural fields and especially an entire catchment. The manner in which parameter variability can be included in soil nitrogen simulation models and the influence of model parameter distributions on simulation results were examined. Plot studies on the behavior of soil nitrogen were conducted from 1984 until 1989 at a site located at the edge of a conventionally managed arable field with crop rotation in southwest Germany. A deterministic, one-dimensional soil nitrogen simulation model was developed and calibrated with field data from the plot studies and a sensitivity analysis was carried out. The results of the investigation revealed that the model could adequately describe observed soil nitrogen behavior as demonstrated by a comparison of calculated and measured soil nitrogen data. In addition it was clear that, for an estimate of the areal leaching of nitrogen, the spatial variability of many soil nitrogen model parameters had to be considered. However, if the spatial distribution of the model parameter was known, this could be achieved with Monte Carlo simulation. It also appeared that, for the case of lognormal parameter distributions, use of the median for the hydraulic conductivities of such distributions in the simulation models provided nitrate leaching values that resembled the true values closely. (See also W91-07253) (Korn-PTT)
W91-07296

STOCHASTIC MODELLING OF SOLUTE TRANSPORT IN GROUNDWATER: APPLICATION TO A FIELD TRACER TEST.
Florida Univ., Gainesville. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 2F.
W91-07302

NETWORK GEOMETRY AND SPATIAL UNCERTAINTY IN GROUNDWATER SOLUTE TRANSPORT MODELLING.
Universitaet fuer Bodenkultur, Vienna (Austria). Inst. fuer Wasserwirtchaft.
For primary bibliographic entry see Field 2F.
W91-07305

ADSORPTION OF CYANAZINE ON PEAT AND MONTMORILLONITE CLAY SURFACES.
Estacion Experimental del Zaidin, Granada (Spain).
G. D. Cancela, E. R. Taboada, and F. Sanchez-Rasero.
Soil Science SOSCAK, Vol. 150, No. 6, p 836-843, December 1990. 5 fig, 3 tab, 21 ref. CAYCIT Contract No. PR84-0160-C04-02.

Descriptors: *Adsorption kinetics, *Cation exchange, *Clay minerals, *Cyanazine, *Herbicides, *Montmorillonite, *Path of pollutants, *Soil chemistry, Equilibrium, Groundwater pollution, Protonation, Rate constants, Temperature effects, Thermodynamics.

The adsorption of cyanazine, an active herbicide, by peat and montmorillonite is studied as a function of the crystal chemical characteristics of exchangeable cations and temperature. The adsorption kinetics of cyanazine on peat shows that the adsorption equilibrium is reached within 1 hour. The values of the rate constants of the reaction seems to indicate that the adsorption rate of cyanazine is mainly controlled by the diffusion process. The order of adsorption of cyanazine by peat is as follows: proton-peat> Cu(2+)-peat > Ca(2+)-peat > Co(2+)-peat > Mg(2+)-peat > K+-peat. The thermodynamic parameters seem to point to an adsorption mechanism by hydrogen bonds, although in the acidic and Cu(2+) samples a protonation process and adsorption of the protonated species is also likely. The values of the adsorption rate constant of cyanazine by montmorillonite is ten times higher than that for peat. The adsorption of cyanazine by montmorillonite follows this order: Cu(2+)-montmorillonite > Co(2+)-montmorillonite > proton-montmorillonite; the adsorption on Cu(2+)-montmorillonite is five times greater than on the other samples. For the Cu(2+) samples, the thermodynamic parameters seem to point to a mechanism of direct coordination cyanazine-Cu(2+). The most probable mechanism for the adsorption of cyanazine by the Co(2+) sample is by physical bonding. For the proton sample, the mechanism is physical adsorption and an ionic mechanism according to the following reaction: proton-montmorillonite + cyanazine -> montmorillonite-proton-cyanazine. (Author's abstract)
W91-07332

KINETICS OF SULFATE DESORPTION FROM TWO SPODOSOLS OF THE LAURENTIANS, QUEBEC.
Montreal Univ. (Quebec). Dept. of Geography.
For primary bibliographic entry see Field 5C.
W91-07333

INITIAL STORM EFFECTS ON MACROPORE TRANSPORT OF SURFACE-APPLIED CHEMICALS IN NO-TILL SOIL.
Agricultural Research Service, Coshocton, OH. North Appalachian Experimental Watershed.
M. J. Shipitalo, W. M. Edwards, W. A. Dick, and L. B. Owens.
Soil Science Society of America Journal SSSJD4, Vol. 54, No. 6, p 1530-1536, November/December 1990. 3 fig, 5 tab, 31 ref.

Descriptors: *Groundwater pollution, *Path of pollutants, *Soil porosity, *Soil water, *Tillage, Agriculture, Atrazine, Leaching, Percolation, Rainfall, Simulated rainfall, Temporal distribution.

Previous research has established that macropores can rapidly transmit water through soil. This observation has raised concern that macropores may also promote rapid movement of agricultural chemicals to groundwater, a particular concern for no-till fields where lack of disruption by tillage can lead to the development of extensive macropore systems. In order to investigate the effect of initial rainfall on chemical transport, strontium bromide hexahydrate and atrazine were surface-applied to six 30 by 30 by 30 cubic cm blocks of undisturbed soil obtained from a 25-year-old, no-till corn (Zea mays) field with evidence of well-defined macropore attributable to earthworm activity. Half of the blocks then received a one hour, 5 mm simulated rain, which did not produce percolate. Two days later, the blocks received a half hour, 30 mm simulated rain, followed by another half hour simulated rain one week later. The remaining blocks received only the two 30 mm events. An average of 12% of the applied water passed through all the blocks during and shortly after the first 30 mm rain. Bromide, strontium and atrazine losses in this percolate were 7, 10, and 2 times less, respectively, from blocks that received the 5-mm rain than from blocks not receiving this initial, light rain. The second 30 mm rain on the blocks not receiving the initial 5 mm produced 1.6 times more percolate than the first 30 mm rain. Yet, transport and flow-weighted average concentrations of bromide, strontium and atrazine were all reduced. These results indicated that the first storm after application can move solutes into the soil matrix, thereby reducing the potential for transport in macropores during subsequent rainfall events. (Author's abstract)
W91-07339

ACETONITRILE AND ACRYLONITRILE SORPTION ON MONTMORILLONITE FROM BINARY AND TERNARY AQUEOUS SOLUTIONS.
Delaware Agriculture Experiment Station, Newark.
Z. Z. Zhang, D. L. Sparks, and N. C. Scrivner.
Soil Science Society of America Journal SSSJD4, Vol. 54, No. 6, p 1564-1571, November/December 1990. 6 fig, 17 ref.

Descriptors: *Acetonitrile, *Acrylonitrile, *Montmorillonite, *Organic compounds, *Path of pollutants, *Soil contamination, *Soil physical properties, *Soil water, Bonding, Carbon radioisotopes, Cation exchange, Competition, Kinetics, Sorption, Spectrometry.

Three different measurements were made to gain mechanistic information on clay-organic interactions in aqueous environments containing multiple organics. The sorption of acetonitrile and acrylonitrile on K, Na, Ca, and Mg montmorillonite from binary and ternary aqueous solutions were determined using a carbon-14 isotope tracer method. The infrared spectra of acrylonitrile in solution and absorbed on montmorillonite were recorded on a Fourier-transform infrared spectrometer and the c-axis spacings of montmorillonites in the acrylonitrile solutions were determined by x-ray diffraction. The sorption of acetonitrile and acrylonitrile from ternary solutions on K montmorillonite was competitive across the entire concentration range. The sorption was slightly competitive at lower concentrations on Na, Ca, and Mg montmorillonite, but enhanced at higher concentrations. The competitive sorption on K montmorillonite was probably associated with the decrease in the interfacial volume, since the layers of K montmorillonite were collapsed at higher concentrations, while the enhanced sorption on Na, Ca and Mg montmorillonite appeared to be caused by an increase in the partition coefficient as more organic molecules

entered the interfacial phase. These results led to the conclusion that the sorption of acetonitrile and acrylonitrile on montmorillonite was not due to specific bonding between the organic molecules and the clay surfaces, but rather to a partition between the interfacial phase and the bulk solution phase. (Author's abstract)
W91-07343

KINETICS OF SULFATE DESORPTION FROM SOIL.
Agricultural Research Service, Durant, OK. Water Quality and Watershed Research Lab.
For primary bibliographic entry see Field 2G.
W91-07344

CATION REMOVAL DURING APPLICATION OF ACID SOLUTIONS INTO AIR-DRY SOIL COLUMNS.
NSI Technology Services Corp., Ada, OK.
K. H. Liu, R. S. Mansell, and R. D. Rhue.
Soil Science Society of America Journal SSSJD4, Vol. 54, No. 6, p 1747-1753, November/December 1990. 6 fig, 6 tab, 2 ref.

Descriptors: *Acid rain, *Cation exchange, *Path of pollutants, *Soil chemistry, *Soil contamination, *Water pollution effects, Error analysis, Hydrogen ion concentration, Infiltration, Leaching.

Acidic deposition is considered an environmental problem that may be modifying the forest soil, and that affects the forest soil's cation-exchange status. Cation removal from laboratory columns of Cecil soil (a clayey, kaolinitic, thermic Typic Kanhapludult) was evaluated proportional to the proton concentration of the acidic input solution. Also, the effective-charge balance of major cations in the soil was measured after termination of acid infiltration. Aqueous HCl solutions of pH 3.9 and 4.9 were applied with constant flux to columns of initially air-dry topsoil and subsoil until approximately 30 pore volumes of effluent had been collected. Larger quantities of cations were leached by the pH 3.9 solution. The ratio of cations removed in the two cases was considerably less (< 2-fold) than the 10-fold H ion ratio of the two input acid solutions. The effective-charge balance error of major cations was greatest for the high-pH solution. Differences in effective-charge balance of major cations were greater for columns of subsoil than for topsoil. Applications of acid (HCl) solutions definitely accelerated leaching losses of cations from the forest Cecil soil. (Author's abstract)
W91-07357

ALUMINUM AND ORGANIC MATTER MOBILIZATION FROM SOIL INFILTRATED WITH ACIDIFIED CALCIUM SULFATE SOLUTIONS.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Crop and Soil Environmental Sciences.
For primary bibliographic entry see Field 2G.
W91-07358

AGRICULTURE AND WATER QUALITY: OLD PROBLEM, NEW URGENCY.
Florida Univ., Gainesville. Dept. of Food and Resource Economics.
R. Carriker, and A. Purvis.
Southern Journal of Agricultural Economics, Vol. 22, No. 1, p 27-32, 1990. 18 ref.

Descriptors: *Agricultural chemicals, *Agriculture, *Drinking water, *Groundwater pollution, *Nonpoint pollution sources, *Water pollution sources, History, Legal aspects, Public opinion, Regulations, Research, Water quality.

Groundwater is a source of drinking water for almost 50% of the United States population. Agricultural sources of contamination have become the object of public concern because agricultural chemicals have been found in groundwater in several highly publicized instances around the country. The presence of agricultural chemicals in groundwater has resulted in large public expenditures for remedial measures. The growing public concern about agriculture and water quality has been accompanied by an increasingly negative view of agriculture and the land grant colleges on the part of the public. Although agricultural impacts on water quality have been recognized for several decades, the current emphasis on agricultural contamination of groundwater attaches a heightened sense of urgency to the issues. The effect of agriculture on water resources was recognized early in US history. However, the perceptions and urgency of environmental issues in general and water quality in particular have become more focused over time. The phenomenon of rival paradigms (different world views that, by their nature, inhibit communication between adherents to them) makes the acceptance of suggestions for new ways of achieving agricultural pest control difficult for the research establishment. One result of the exclusionary effects is that budgetary requests to Congress usually are confined to program maintenance. The agricultural production technologies in vogue during the past couple of decades are changing and will probably be modified further in the future. Society needs environmental quality and a viable agriculture. The divisive issues will go unresolved unless the barriers to communication are successfully identified and eliminated. Some immediate steps include seminars and workshops. In extension programs, more attention must be paid to the reasons for government regulation of wetland conversion, wastewater discharges, or consumptive water use. Efforts should be made to propose specific problem-solving research projects, avoiding the tendency to address only hypothetical problems or to focus exclusively on ongoing disciplinary research. Finally, there is a critical role for education. (Brunone-PTT)
W91-07361

MULTIVARIATE CORRELATION ANALYSIS AND ITS APPLICATION IN ENVIRONMENTAL ANALYSIS.
Friedrich-Schiller-Univ., Jena (German D.R.). Inst. fuer Anorganische und Analytische Chemie.
For primary bibliographic entry see Field 7C.
W91-07370

IMPACT OF REJECT WATER FROM THE DESALINATION PLANT ON GROUND WATER QUALITY.
Andhra Univ., Waltair (India). School of Chemistry.
N. Someswara Rao, T. N. V. Venkateswara Rao, G. Babu Rao, and K. Venu Gopala Rao.
Desalination DSLNAH, Vol. 78, No. 3, p 429-437, October 1990. 1 fig, 3 tab, 17 ref.

Descriptors: *Desalination plants, *Desalination wastes, *Groundwater pollution, *Groundwater quality, *India, *Saline water, *Water pollution sources, Chlorides, Drinking water, Effluent seepage, Hardness, Ion exchange, Pipes, Seasonal variation, Seepage, Soil properties, Water pollution, Water supply.

Some villages on the east coast of India in Andhra Pradesh face acute drinking water problems because of the contamination of groundwater by the seepage of reject water from a desalination plant. The abnormal increase in hardness of the groundwater was explained by carrying out simulation experiments in the laboratory. Hardness and chloride of well water in the area surrounding the desalination plant are high even in December, when hardness and chloride content generally decease due to dilution by rainwater. Laboratory studies demonstrated that the abnormal increase in hardness may be attributed to the ion exchange properties of the soil, with the sodium in the reject water seeping through the soil and exchanging with calcium. The plant produces water of the best quality December through February, and later the water slowly becomes hard and saline until summer, when there is an acute shortage of potable water. The contamination can be prevented if seepage is controlled. This can be achieved by discharging the reject water through seepage-proof cement pipes or concrete canals to the sea or far away from the plant and inhabited areas. (Doria-PTT)
W91-07391

TEMPORAL VARIABILITY OF ATMOSPHERIC LEAD CONCENTRATIONS AND FLUXES OVER THE NORTHWESTERN MEDITERRANEAN SEA.
Paris-7 Univ. (France). Lab. de Physico-Chimie de l'Atmosphere.
E. Remoudaki, G. Bergametti, and P. Buat-Menard.
Journal of Geophysical Research (D) Atmosphere JGRDE3, Vol. 96, No. 1, p 1043-1055, January 20, 1991. 6 fig, 2 tab, 23 ref. European Economic Communities Environmental Research Programme Grant B/87000259.

Descriptors: *Chemistry of precipitation, *Lead, *Mediterranean Sea, *Path of pollutants, *Precipitation scavenging, Aerosols, Air masses, Air pollution sources, Coasts, Corsica, Heavy metals, Precipitation, Seasonal variation.

Beginning in 1985, daily 24-hour aerosol samples were collected on 0.4-micron pore size filters at a coastal location in northwestern Corsica. Total atmospheric deposition (wet + dry) was sampled between February 1985 and October 1987 with a collection period of about 15 days. As indicated by 3-dimensional air mass trajectories, lead aerosol articles collected at this site are primarily derived from European continental source regions. The variability of lead aerosol concentrations on both daily and seasonal time scales is primarily due to the scavenging of lead aerosol particles by rain rather than to changes in source regions. These results suggest that the ratio between the total atmospheric deposition of Pb and the corresponding mean daily precipitation (mdp) rate is not constant. This ratio reaches a maximum during the Mediterranean summer. This difference is attributed to wet scavenging processes which wash a more loaded atmosphere during the dry season than during the wet season. The precipitation frequency is a major factor influencing seasonal variability of the total atmospheric deposition of lead over the western Mediterranean. An intermediate value of precipitation frequency allows sufficient reloading of the atmosphere with long-range transported Pb aerosol particles as well as efficient scavenging by precipitation events. (Author's abstract)
W91-07396

REGIONAL NUMERICAL SULFUR DISPERSION MODEL USING A METEOROLOGICAL MODEL WITH EXPLICIT TREATMENT OF CLOUDS.
Bergen Univ. (Norway). Dept. of Meteorology.
For primary bibliographic entry see Field 2B.
W91-07402

STRONG SIMILARITIES IN SEASONAL CONCENTRATION RATIOS OF SO4(2-), NO3(-) AND NH4(+) IN PRECIPITATION BETWEEN SWEDEN AND THE NORTHEASTERN US.
New York Botanical Garden, Bronx, NY. Inst. of Ecosystem Studies.
L. O. Hedin, L. Granat, G. E. Likens, and H. Rohde.
Tellus TELLAL, Vol. 42B, No. 5, p 454-462, 1990. 6 fig, 1 tab, 27 ref.

Descriptors: *Acid rain, *Ammonium, *Chemistry of precipitation, *Nitrates, *Path of pollutants, *Scandinavia, *Sulfates, Aerosols, Chemical reactions, Fate of pollutants, Ions, Nitrogen oxides, Seasonal variation, Sulfur dioxide.

Records of precipitation chemistry from central Scandinavia and the northeastern United States spanning 21 years were analyzed to compare seasonal variations of three major pollutant ions, sulfate, nitrate, and ammonium. Seasonal variations in concentrations of the individual ions were distinctly different between the two regions. However, despite these differences, strong and unexpected similarities were found in seasonal variations of the concentration ratios of nitrate to sulfate, ammonium to nitrate, and ammonium to sulfate. A preliminary analysis suggests that these similarities are due to similarities between the two regions in chemical transformation and removal processes affecting

sulfate and nitrate in the atmosphere, and to a coupling between ammonium and sulfate aerosol in long-range transport. Ion ratios appear to be less sensitive to seasonal variations in SO2 and NOx emissions compared to individual ion concentrations. (Author's abstract)
W91-07404

IMPROVING ON-TARGET PLACEMENT OF PESTICIDES.
Ohio State Univ., Wooster. Lab. for Pest Control Application Technology.
For primary bibliographic entry see Field 5G.
W91-07444

HERBICIDES IN GROUND AND SURFACE WATER IN THE MID-CONTINENTAL UNITED STATES: A RESEARCH PLAN.
Geological Survey, Reston, VA.
S. E. Ragone, M. R. Burkart, E. M. Thurman, and C. A. Perry.
IN: Emerging Priorities for Agricultural Research in the 1990s. Agricultural Research Institute, Bethesda. 1988. p 55-67. 3 fig, 16 ref.

Descriptors: *Agricultural chemicals, *Atrazine, *Groundwater pollution, *Herbicides, *Surface water, *Water pollution, *Water pollution sources, *Water quality control, Corn, Field tests, Hydrologic systems, Laboratory methods, Soybeans, Variability factors.

A plan is described to study the effects of agricultural practices on the occurrence of herbicides in ground and surface water. The plan is currently being reviewed by Federal and State agencies and selected universities. The mid-continental USA was selected as the study area because the region is dominated by a cropland devoted to corn and soybean production where herbicide applications are substantial. Atrazine was selected as a representative herbicide because it is the most widely used triazine herbicide in the midwest and has the longest history of continuous use. The plan should be applicable to other areas and to other agrichemicals. Information from the planned research should provide the scientific basis for water-resources managers to develop guidelines for protecting water quality from agricultural contamination. Full implementation of the plan may take 5 to 10 years or more depending on the availability of information and the need for additional studies. The plan provides procedures that integrate information from a wide variety of laboratory, field, and regional studies to identify major processes and factors that affect atrazine fate and transport throughout the hydrologic system. An important part of this plan is to define the scale of factor variability. A research matrix is developed that uses a mass-balance concept to account for the distribution of atrazine in the environment and to identify areas of needed research. A geographic information system is described that will permit interpretation of regional information and evaluation of spatial variability of important natural and human factors. The plan includes the use of statistical methods to relate regional patterns of atrazine occurrence in ground and surface water to a limited number of factors. (See also W91-07443) (Author's abstract)
W91-07446

MECHANISMS OF FOREST RESPONSE TO ACIDIC DEPOSITION.
For primary bibliographic entry see Field 5C.
W91-07465

OVERVIEW AND SYNTHESIS.
National Council of the Paper Industry for Air and Stream Improvement, Inc., New York.
For primary bibliographic entry see Field 5C.
W91-07466

EFFECTS OF ACIDIC DEPOSITION ON THE CHEMICAL FORM AND BIOAVAILABILITY OF SOIL ALUMINUM AND MANGANESE.
DowElanco, Midland, MI. Environmental Chemistry Lab.
For primary bibliographic entry see Field 5C.
W91-07468

RATES OF NUTRIENT RELEASE BY MINERAL WEATHERING.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Crop and Soil Environmental Sciences.
G. N. White, S. B. Feldman, and L. W. Zelazny.
IN: Mechanisms of Forest Response to Acidic Deposition. Springer-Verlag New York, Inc., New York. 1990. p 108-162. 2 fig, 5 tab, 136 ref.

Descriptors: *Acid rain, *Acid rain effects, *Acidic soils, *Acidification, *Forest soils, *Minerals, *Nutrient concentrations, *Weathering, Buffering, Ecological effects, Forest ecosystems, Reviews, Soil properties, Trees.

Mineral weathering is an important mechanism of soil resistance to effects of acidic deposition since weathering reactions are sinks for protons and sources of plant nutrients. Incomplete knowledge of weathering rates is a major source of uncertainty in assessments of potential effects of acidic deposition on forest soil fertility and tree nutrition. Rates of nutrient release via mineral weathering, including the processes of physical and chemical weathering and rate-controlling factors in nutrient release and weathering are reviewed. Factors involved are temperature, leaching and internal soil drainage, soil reaction, redox potential, biotic factors, particle size and specific surface effects, specific weatherability of minerals, chemical kinetics, topography, anthropogenic effects, and the relationship of weathering to soil-forming factors. Although data from laboratory dissolution kinetic studies give results similar to those predicted by earlier mineral persistence indices, the data cannot easily be used in predictive field models. This results from the unrealistic methods required for data collection such as high solution-to-soil ratios, low pH values, and unrealistic concentrations of complexes. The release of nutrients during weathering largely determines the capacity of soils to be buffered against long-term chronic nutrient depletion that may be attributed to acid deposition. However, current information is inadequate to determine the effects of acidic deposition on mineral weathering rates, and more research is essential. (See also W91-07465) (VerNooy-PTT)
W91-07469

CHEMICAL AND ECOLOGICAL EVIDENCE ON THE ACIDIFICATION OF WELSH LAKES AND RIVERS.
University Coll., Cardiff (Wales). School of Pure and Applied Biology.
For primary bibliographic entry see Field 2H.
W91-07473

RECENT ACIDIFICATION OF UPLAND LAKES IN NORTH WALES: PALAEOLIMNOLOGICAL EVIDENCE.
Minnesota Univ., Minneapolis. Limnological Research Center.
For primary bibliographic entry see Field 2H.
W91-07474

ATMOSPHERIC DEPOSITION.
NRA Welsh Region, Cardiff.
For primary bibliographic entry see Field 5C.
W91-07475

ROLE OF GEOLOGY AND SOILS IN CONTROLLING SURFACE WATER ACIDITY IN WALES.
Institute of Terrestrial Ecology, Grange-over-Sands (England). Merlewood Research Station.
M. Hornung, S. Le-Grice, N. Brown, and D. Norris.
IN: Acid Waters in Wales. Monographiae Biologicae Volume 66. Kluwer Academic Publishers, Norwell, Massachusetts. 1990. p 55-66. 4 fig, 3 tab, 17 ref.

Descriptors: *Acid rain effects, *Acidic water, *Acidification, *Geochemistry, *Soil chemistry, *Wales, Agriculture, Air pollution, Bedrock, Buffer capacity, Hydrogen ion concentration, Land use, Maps, Neutralization, Pollution effects, Soils, Streams, Surface water, Water chemistry, Water quality.

On a regional scale, geology and soils are the major factors influencing surface water chemistry and acidity. These influences on surface water acidity in Wales was examined. The classification of rocks based on their acid neutralizing capacity has been applied to the solid geology of Wales using published maps and data on the lithology and mineralogy of the main stratigraphic units, to produce a map showing distribution of rocks with little, low, moderate or infinite neutralizing capacities. On the basis of bedrock geology, naturally acidic, low conductivity waters, sensitive to acidification, are predicted to occur over much of northwest, central and southwest Wales. In contrast, the surface waters of much of eastern Wales are, on the basis of solid geology, predicted as being moderately to well buffered. To examine the influence of soils a classification method based on the soil neutralizing capacity was used. This analysis gave two classes of soils: acid soils with little or no neutralizing capacity and non-acid to weakly acidic soils with moderate to large neutralizing capacity. Agricultural land use maps were used to identify areas where liming had probably changed soil chemistry and thus soil neutralizing capacity. The maps of the occurrence of 'acid' and 'non-acid' soils and of rocks with low, moderate, high and infinite buffering capacity were combined to show the number of soil and rock combinations with differing buffering capacities in Wales. These soil-rock combinations were used to predict the likely occurrence of acidic, sensitive waters, and possible changes in stream acidity with flow. The predicted distribution of acidic, low conductivity waters thus obtained was tested using the results from a regional survey of water quality by the Welsh Water Authority, with good agreement. (See also W91-07472) (Agostine-PTT)
W91-07476

DISSOLVED INORGANIC ALUMINUM IN ACIDIC STREAM AND SOIL WATERS IN WALES.
Institute of Hydrology, Wallingford (England).
C. Neal, B. Reynolds, P. A. Stevens, M. Hornung, and S. J. Brown.
IN: Acid Waters in Wales. Monographiae Biologicae Volume 66. Kluwer Academic Publishers, Norwell, Massachusetts. 1990. p 173-188. 7 fig, 3 tab, 39 ref.

Descriptors: *Acid rain, *Acid rain effects, *Acid streams, *Acidification, *Aluminum, *Soil water, *Wales, Bedrock, Case studies, Coniferous forests, Dissolved solids, Groundwater, Land use, Moorlands, Soil profiles, Variability, Watersheds.

The behavior of inorganic aluminum is explored for the Welsh uplands using specific case studies for the Plynlimon catchment in central Wales and the Beddgelert catchment in northern Wales. Both of these catchments are presently being studied by researchers at the Institute of Hydrology (IH) and the Institute of Terrestrial Ecology (ITE). Comparisons are then made with regional streamwater data, collected by the Welsh Water Authority (WWA), and soil water data from the numerous catchment studies in the Llyn Brianne area of south Wales to provide a picture of inorganic aluminum behavior on a regional scale. Large temporal and spatial variations in aluminum concentration occur in Welsh streamwaters. Hydrological and land use controls primarily account for these variations. Aluminum and H(+) are highly correlated so that the most acidic streams have the highest aluminum concentrations. The temporal variation in both aluminum and H(+) concentrations can be explained in terms of the mixing of waters from the upper soil (L, O, A horizons) and groundwater source, each end-member composition being determined by the bedrock type/reactivity and the land use history of the soils. Variations in stream and soil water aluminum concentrations in the order semi-natural moorland < conifer forested moorland < recently harvested

forest can be explained by ion exchange reactions related to changes in the anion concentrations passing through the system, and weathering. In no case can the streamwater aluminum concentration be related simply to Al(OH)3 and Al(OH)SO4 solubility controls. The same is also true for soil waters. It is concluded that the classic Al(OH)3 solubility relationships assumed to hold within all the predictive models are inappropriate. (See also W91-07472) (Agostine-PTT)
W91-07483

DETERMINATION OF ALUMINUM SPECIATION IN ACID WATERS.
University Coll. of Swansea (Wales). Dept. of Chemical Engineering.
For primary bibliographic entry see Field 5A.
W91-07484

CATCHMENT CHARACTERISTICS AND BASIN HYDROLOGY: THEIR EFFECTS ON STREAMWATER ACIDITY.
NRA Welsh Region, Cardiff.
S. C. Bird, R. P. D. Walsh, and I. G. Littlewood.
IN: Acid Waters in Wales. Monographiae Biologicae Volume 66. Kluwer Academic Publishers, Norwell, Massachusetts. 1990. p 203-221. 7 fig, 1 tab, 34 ref.

Descriptors: *Acid rain effects, *Acid streams, *Acidification, *Basins, *Hydrology, *Path of pollutants, *Stream pollution, *Streams, *Wales, *Watersheds, Basin morphometry, Geology, Runoff, Soil types, Topography, Variability.

The influence of climate, basin morphometry, and hydrology on streamwater acidity in upland Wales was studied. Using the Llyn Brianne study catchments as examples, the effects of varying catchment morphology on stream responses to rainfall and on acidity are examined along with the key role played by runoff processes and the runoff responses of streams and how they reflect differences in topography, soils and land use. Current research suggests that there are strong interrelationships between topography, soil type and vegetation on the one hand, and runoff processes and their hydrochemistry on the other. Hence, a clear knowledge of catchment hydrology is crucial to the understanding of acidification problems in upland Wales. Comparison of catchments on the basis of morphometry offers a good initial indication of any likely differences in catchment hydrological response. Catchment morphometry, allied with the differences in land use, vegetation cover, soils, geology and climate, largely control the volume and timing of individual catchment runoff responses. They also determine the complex hydrological pathways taken by the runoff and hence the range of soil and rock environments encountered. Subject to the quality of the bulk precipitation inputs, hydrological factors are clearly important in determining variations in the hydrochemical response of streams. (See also W91-07472) (Agostine-PTT)
W91-07485

WATER QUALITY CHANGES FROM INPUT TO STREAM.
Institute of Terrestrial Ecology, Grange-over-Sands (England). Merlewood Research Station.
M. Hornung, B. Reynolds, P. A. Stevens, and S. Hughes.
IN: Acid Waters in Wales. Monographiae Biologicae Volume 66. Kluwer Academic Publishers, Norwell, Massachusetts. 1990. p 223-240. 5 fig, 4 tab, 24 ref.

Descriptors: *Acid rain effects, *Acidification, *Path of pollutants, *Stream pollution, *Streams, *Wales, *Water chemistry, Acid rain, Aluminum, Bicarbonates, Calcium, Coniferous forests, Ecosystems, Geology, Land use, Liming, Magnesium, Moorlands, Sodium, Soil types, Variability, Vegetation, Water quality.

Data from a series of studies in upland Wales was used to explore the changes in chemistry as precipitation moves through the vegetation, soil and bedrock compartments of terrestrial ecosystems. The three main study sites are Beddgelert Forest in north Wales, the Plynlimon experimental catchments, and the Llyn Brianne experimental catchments in central Wales. Together the sites cover a range of vegetation types/land uses, soils and some variation in bedrock geology. Significant changes in solute chemistry, including acidity, take place as waters move through terrestrial ecosystems from precipitation to stream. The acidity of precipitation may be increased or decreased as it moves through vegetation canopies but the concentration of mobile acid anions is almost always increased. This may be more important than throughfall acidity in influencing reactions in the acid upland soils of Wales, and acidification of surface waters. In upland Wales the replacement of moorland by forest plantations results in an increase in the concentration and flux of mobile anions into soils. The chemistry of soil waters varies both between soils and between horizons of a given soil. The chemistry of the soil drainage waters is modified by land use. Waters from soils below coniferous plantations have higher solute concentrations than those from similar soils beneath moorland; the largest increases are shown by aluminum, sodium and mobile acid ions. Liming, in connection with land improvement, reduces soil water acidity and the soils become a source of water with relatively high concentrations of calcium, magnesium and bicarbonate. The chemistry including the acidity, of the streamwater will change in response to the changes in the proportions of the inputs. (See also W91-07472) (Agostine-PTT)
W91-07486

INFLUENCE OF LAND MANAGEMENT ON STREAM WATER CHEMISTRY.
NRA Welsh Region, Cardiff.
S. C. Bird, S. J. Brown, and E. Vaughan.
IN: Acid Waters in Wales. Monographiae Biologicae Volume 66. Kluwer Academic Publishers, Norwell, Massachusetts. 1990. p 241-253. 4 fig, 3 tab, 11 ref.

Descriptors: *Acid rain effects, *Acidification, *Land management, *Scotland, *Stream pollution, *Streams, *Wales, *Water chemistry, Chemical properties, Comparison studies, Coniferous forests, Land use, Moorlands, Seasonal variation, Storms, Watersheds.

A number of comparative catchment studies have been established in Scotland and Wales to quantify short term, seasonal and longer term trends in stream chemistry with respect to land management practices. The typical patterns of stream water chemistry observed for different types of land use in upland Wales are described using data from the Llyn Brianne study. Water chemistry data for twelve of the Llyn Brianne study catchments are used to illustrate the differences between the streams in relation to land use, including five reference catchments and seven catchments where land management techniques have subsequently been applied. Consideration is given to descriptions of seasonal changes, using data from a routine spot sampling program. Short-term changes resulting from storm episodes are assessed using continuous monitoring data and associated intensive sampling records. The data for moorland streams demonstrate that within groups of streams with similar hardness, significant differences in stream chemistry may occur. Associated, in part, with the existence of seasonal patterns in stream water chemistry, significant chemical inter-relations may be demonstrated for the moorland streams. The most notable feature of the streams draining conifer forests is their greatly increased acidity compared with streams draining moorlands within similar hardness categories. As with the moorland streams, the conifer forest streams display a number of seasonal variations. The acid oak woodland stream studied displays less acid conditions than all but one other stream. Stream water chemistry in this catchment exhibits few of the seasonal patterns or important chemical interrelationships found in other streams. (See also W91-07472) (Agostine-PTT)
W91-07487

HYDROCHEMICAL MODELLING OF ACIDIFICATION IN WALES.
Institute of Hydrology, Wallingford (England).
P. G. Whitehead, T. J. Musgrove, and B. J. Cosby.
IN: Acid Waters in Wales. Monographiae Biologicae Volume 66. Kluwer Academic Publishers, Norwell, Massachusetts. 1990. p 255-277. 11 fig, 8 tab, 25 ref.

Descriptors: *Acid rain, *Acid rain effects, *Acidification, *Model studies, *Path of pollutants, *Surface water, *Wales, *Water chemistry, Air pollution, Buffer capacity, Liming, Mathematical studies, Monte Carlo method, Paleoecology, Reforestation, Subsurface water, Watersheds.

The effects of afforestation and deposition reduction reductions are investigated using the long-term acidification model MAGIC (Model of Acidification of Groundwaters in Catchments). MAGIC provides a tool by which soil processes can be simultaneously and quantitatively linked to examine the impact of acid deposition on surface water chemistry over time scales of several years to several decades. The model reconstructs historical trends in acidification, compares well with the trends in acidification derived from palaeoecological analysis and provides some measure of confidence in using the model to predict future trends. The poorly buffered upland catchments in Wales are significantly affected by acid deposition, and are likely to be affected for some time even if deposition is reduced. Any short-term improvement will probably be effected by liming and land management. Afforestation in the poorly buffered Welsh Uplands causes a major increase in acidification following the increased scavenging of sea-salts and anthropogenic sources of acidity. The survey region within Wales has been simulated quite accurately by the MAGIC model. Close reproduction of all the major variables was achieved in terms of their distribution across the region. The present analysis indicates that Wales is particularly vulnerable to further pollutant deposition. The buffering capacity has declined in the region and the acidification of its streams is significant. The survey region as a whole is likely to show little change in the rate of acidification under an assumed deposition decrease of 30%. A deposition reduction of the order of 50% is required to reverse acidification in Wales. (See also W91-07472) (Agostine-PTT)
W91-07488

LLYN BRIANNE: ACID DEPOSITION MODELING.
Stirling Univ. (Scotland). Dept. of Environmental Science.
S. E. Metcalfe, and R. G. Derwent.
IN: Acid Waters in Wales. Monographiae Biologicae Volume 66. Kluwer Academic Publishers, Norwell, Massachusetts. 1990. p 299-309. 2 fig, 2 tab, 12 ref, append.

Descriptors: *Acid rain, *Acid rain effects, *Acidification, *Model studies, *Path of pollutants, *Wales, *Watersheds, Emission control, Llyn Brianne, Nitrogen, Soil water, Sulfur, Surface water, United Kingdom, Water chemistry, Water pollution sources.

A model of atmospheric pollution transport has been applied to examine the relationship between pollutant emissions and deposition with particular reference to the Llyn Brianne catchment area. The current major sources of pollutants (by direction and source height) were identified and possible effects of various emission reduction strategies were investigated. The computer model used in the study is one of the 'receptor oriented' type in which the nature and quantity of pollutants of nitrogen and sulfur are followed until arrival at a predetermined receptor site (Llyn Brianne). The model follows the changing chemical composition of a box, or parcel, of air as it is carried along by the wind (a Lagrangian trajectory model). The modeled deposition of sulfur and nitrogen could be used in models of catchment behavior to assess the possible effects of reductions in atmospheric pollutant loads on soil and surface water chemistry. The model output indicates the great importance of high level United Kingdom (UK) sources of S to the composition of rainfall reaching the Llyn

Brianne catchment. The modeling exercise using different emission control strategies indicates that reduction in UK power station emissions can lead to a noticeable decline in pollutant levels within the country generally and specifically at Llyn Brianne. The non-linear nature of emission-deposition relationships is well illustrated. The response to emissions reductions is, however, most marked in the heavily polluted sector. (See also W91-07472) (Agostine-PTT)
W91-07490

ACIDIC PRECIPITATION, VOL. 1: CASE STUDIES.
For primary bibliographic entry see Field 5C.
W91-07492

ACIDIC DEPOSITION ON WALKER BRANCH WATERSHED.
Oak Ridge National Lab., TN. Environmental Sciences Div.
For primary bibliographic entry see Field 5C.
W91-07493

ACIDIC PRECIPITATION: CASE STUDY SOLLING.
Goettingen Univ. (Germany, F.R.). Forschungszentrum Waldoekosysteme - Waldsterben.
For primary bibliographic entry see Field 5C.
W91-07494

ALBIOS: A COMPARISON OF ALUMINUM BIOGEOCHEMISTRY IN FORESTED WATERSHEDS EXPOSED TO ACIDIC DEPOSITION.
Maine Univ., Orono. Dept. of Botany and Plant Pathology.
For primary bibliographic entry see Field 5C.
W91-07496

LONG-TERM ACIDIC PRECIPITATION STUDIES IN NORWAY.
Norges Landbrukshoegskole, Aas. Dept. of Soil Sciences.
For primary bibliographic entry see Field 5C.
W91-07497

INFLUENCE OF AIRBORNE AMMONIUM SULFATE ON SOILS OF AN OAK WOODLAND ECOSYSTEM IN THE NETHERLANDS: SEASONAL DYNAMICS OF SOLUTE FLUXES.
Agricultural Univ., Wageningen (Netherlands). Dept. of Soil Science and Geology.
For primary bibliographic entry see Field 5C.
W91-07499

LANGE BRAMKE: AN ECOSYSTEM STUDY OF A FORESTED CATCHMENT.
Goettingen Univ. (Germany, F.R.). Abt. Bodenkunde und Waldernahrung.
For primary bibliographic entry see Field 5C.
W91-07501

ACIDIC PRECIPITATION, VOL. 3: SOURCES, DEPOSITION, AND CANOPY INTERACTIONS.
Advances in Environmental Science. Springer-Verlag New York, Inc., New York. 1990. 332p. Edited by S. E. Lindberg, A. L. Page, and S. A. Norton.

Descriptors: *Acid rain, *Acid rain effects, *Acidification, *Air pollution, *Canopy, *Deposition, *Water pollution sources, Aluminum, Environmental effects, Forests, Nitrogen oxides, Ozone, Statistical analysis, Sulfur compounds, Throughfall, Trace metals, Tracers.

As has been the case with many environmental issues of the twentieth century, acidic precipitation has its origin in emissions to the atmosphere of numerous compounds from both natural and manmade sources. This volume emphasizes the atmospheric aspects of acidic precipitation and all that this term has come to include (e.g. toxic gases such as ozone, trace metals, aluminum, and oxides of nitrogen). It progresses from emissions of the precursors of acidic precipitation to their eventual deposition on environmental surfaces. The chapters describe the sources of acidic and basic airborne substances, their interactions in the atmosphere and with rain droplets, and their reactions with other airborne constituents such as aluminum and other metals. Also discussed are the use of metals as tracers of sources of the precursors of acidic precipitation and as tracers of historical deposition rates, the processes controlling the removal of airborne material as dry deposition and deposition interactions with the forest canopy, and past and future trends in atmospheric emissions and options for their abatement. (See W91-07514 thru W91-07519) (Agostine-PTT)
W91-07513

SOURCES OF ACIDS, BASES, AND THEIR PRECURSORS IN THE ATMOSPHERE.
Brookhaven National Lab., Upton, NY. Environmental Chemistry Div.
R. L. Tanner.
IN: Acidic Precipitation, Vol. 3: Sources, Deposition, and Canopy Interactions. Advances in Environmental Science. Springer-Verlag New York, Inc., New York. 1990. p 1-17. 1 fig, 3 tab. U.S. DOE Contract DE-AC02-76CH00016.

Descriptors: *Acid rain, *Acid rain effects, *Acidification, *Acids, *Air pollution, *Bases, *Chemistry of precipitation, *Path of pollutants, *Water pollution sources, Aerosols, Ammonia, Atmosphere, Clouds, Industrial wastes, Oxidation, Ozone, Powerplants, Precipitation scavenging, Reviews, Sulfur compounds.

The significant pathways by which strong acidic sulfur and nitrogen compounds appear in the troposphere are: (1) direct emission of acidic sulfate aerosols from power plants and other industrial sources; (2) formation of sulfuric acid from sulfur dioxide via a homogeneous, gas-phase oxidation reaction with hydroxide radicals; (3) formation of sulfuric acid from sulfur dioxide by an aqueous-phase reaction with hydrogen peroxide or ozone; (4) formation of nitric acid from nitrogen dioxide via a homogeneous, gas-phase oxidation reaction with hydroxide radicals; and (5) formation of nitric acid (at night) by a combination of gas-phase reaction of nitrogen dioxide with ozone, reaction of NO3 with NO2, and aqueous-phase conversion of N2O5 to nitric acid. These strong acids are partially neutralized in the atmosphere prior to deposition by reaction with ammonia, and to a lesser extent, with alkaline dust. The resulting partially neutralized aerosols and nitric acid vapor are available for scavenging into clouds and rain. Homogeneous reactions of SO2 and NO2 with hydroxide radicals are important for sulfuric and nitric acid formation, respectively, but aqueous-phase oxidation reactions also convert dissolved S(IV) to sulfuric acid within typical cloud and rain droplet lifetimes. Evidence for rapid reaction of ammonia emissions with the principal atmospheric acids (H2SO4 and HNO3) is reviewed. It is clear that the rate at which boundary layer mixing processes produce microscale aerosol equilibrium with gaseous NH3 and HNO3 is critical in determining the availability of acidic aerosols and gases for incorporation into clouds and precipitation. (See also W91-07513) (Agostine-PTT)
W91-07514

AEROSOL SULFUR ASSOCIATION WITH ALUMINUM IN EASTERN NORTH AMERICA: EVIDENCE FOR SOLUBILIZATION OF ATMOSPHERIC TRACE METALS BEFORE DEPOSITION.
Florida State Univ., Tallahassee. Dept. of Oceanography.
For primary bibliographic entry see Field 5C.
W91-07515

SOURCE-RECEPTOR RELATIONSHIPS FOR ATMOSPHERIC TRACE ELEMENTS IN EUROPE.
Norsk Inst. for Luftforskning, Lillestroem.
J. M. Pacyna.
IN: Acidic Precipitation, Vol. 3: Sources, Deposition, and Canopy Interactions. Advances in Environmental Science. Springer-Verlag New York, Inc., New York. 1990. p 49-71. 7 fig, 5 tab, 70 ref.

Descriptors: *Acid rain, *Acid rain effects, *Acidification, *Air pollution, *Path of pollutants, *Trace metals, *Water pollution sources, Acids, Anions, Atmosphere, Europe, Hydrogen ion concentration, Mathematical studies, Meteorological data, Model studies, Organic carbon, Particle size, Reviews, Solubility.

Source receptor relationships are presented for trace elements emitted from various sources in Europe and measured at a number of remote locations. Quantitative and qualitative data for the major sources of trace elements in Europe are reviewed, and the emission data have been used in a long-range transport model to calculate trace element concentrations and deposition patterns. These estimates are verified by measurements, and a few examples are given. It was concluded that the estimates of trace elements emissions can be related to the air concentrations measured at remote locations. However, it has been proven much harder to localize the sources. More measurements are needed to provide the information on the emission rates of trace elements from various technical processes and the efficiency of control equipment for a given source category. Of special importance is the trace element distribution on various-size particles. Generally, the relative solubility of trace elements increases with decreasing particle size. The connection between particle size and solubility may be related to the increased surface area to volume ratio for fine particles, characteristic surface properties of these metals, and the increased free H(+), organic carbon, and strong acid anion concentrations in the fine particle fraction. This may reflect the relationship between trace elements and acidic compounds. More attention should also be given to the chemical form of the emitted trace elements, as this is a key factor for their solubility. Further study of the source-receptor relationships should include these techniques together with the information on the meteorological situation, particularly on air mass trajectories and/or synoptic configurations, and accurate emission inventories. (See also W91-07513) (Agostine-PTT)
W91-07516

HISTORY OF ATMOSPHERIC DEPOSITION OF CD, HG, AND PB IN NORTH AMERICA: EVIDENCE FROM LAKE AND PEAT BOG SEDIMENTS.
Maine Univ. at Orono. Dept. of Geological Sciences.
For primary bibliographic entry see Field 5C.
W91-07517

THROUGHFALL CHEMISTRY AND CANOPY PROCESSING MECHANISMS.
Syracuse Univ., NY. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2K.
W91-07518

SURVEY OF TRACE ELEMENTS IN AGRICULTURAL RESOURCES OF CHILE: WATERS AND SOILS OF THE ELQUI AND LIMARI VALLEYS, IV REGION (PROSEPECCION DE ELEMENTOS TRAZAS EN RECURSOS AGRICOLAS DE CHILE. AGUAS Y SUELOS DE LOS VALLES DE ELQUI Y LIMARI, IV REGION).
Estacion Experimental La Platina, Santiago (Chile).
S. Gonzalez.
Agricultura Tecnica AGTCA9, Vol. 50, No. 1, p 60-70, March 1990, 5 fig, 3 tab, 13 ref. English summary.

Descriptors: *Agricultural watersheds, *Chile, *Path of pollutants, *Soil chemistry, *Trace elements, *Water chemistry, Elqui River, Heavy metals, Limari River, Soil erosion, Vine crops, Water quality standards.

This Study of the Elqui and Limari basins has shown that the water of Limari basin including the

Hurtado, Rapel, Cogoti and Limari rivers are low in dissolved solids and metals (Cu, Mn, Pb, Zn), and that the Turbio river of the Elqui basin had higher amounts of dissolved solids and metals. The high mineral loading of the Turbio was diluted by the Claro river maintaining the levels of the Elqui within the range of tolerance. This study took place between November 1987 and December 1988. The Mn and Cu content of the Elqui and Na content of the lower Limari seldom exceed maximum allowed values. The soils studied represent in part alluvial deposits from the Cordillera of the Andes. The total trace element content of the soils was high, but not as high as would be expected from the climatic conditions. The trace element content was closely related to the content of elements which can be extracted by EDTA. The content of water-soluble material was low. The valley of the Northern Chico has recently been switched over to the monocultural production of table grapes. The Elqui and Limari basins are important in this region which acts as a barrier to the spread of the Atacama desert. The rivers are studied for their potential effect on salination. No contaminants were found in the soils or waters which would cause problems, however, it is not possible to discount the possibility until all possible contaminants such as As, B and cyanides have been included in the study. The major environmental problem is erosion high in the basin which results in active sedimentation. (King-PTT)
W91-07521

MODELLING OF SETTLING AND FLOCCULATION OF FINE SEDIMENTS IN STILL WATER.
National Water Research Inst., Burlington (Ontario). Rivers Research Branch.
For primary bibliographic entry see Field 2J.
W91-07525

MATHEMATICAL MODELING OF HYDRODYNAMICS AND MOVEMENT OF POLLUTION IN A LAGOON SYSTEM (MODELISATION MATHEMATIQUE DE L'HYDRODYNAMIQUE ET DU MOVEMENT DE LA POLLUTION EN SYSTEME LAGUNAIRE).
BCEOM-Service Hydraulique, 259 Avenue de Melgueil, 34280 La Grande Motte, France.
T. Menigault, and H. Dumay.
Houille Blanche HOBLAB, Vol. 1990, No. 6, p 411-416, 1990, 6 fig, 1 tab, append. English summary.

Descriptors: *Bays, *Hydrodynamics, *Marine pollution, *Mathematical models, *Model studies, *Path of pollutants, Finite element method, France, Water pollution management, Water pollution sources, Weather patterns, Wind effects.

A finite-element mathematical model simulating the hydrodynamic behavior of a system of lagoons, canals and rivers, and the advection-diffusion movement of pollutants was applied to the complex system of three lagoons, two rivers, two canals, and three outlets to the sea around Palavas, France. Possible sources of pollution include the waste treatment plant at Cereirede, the waste treatment plant at Palavas, the waste treatment plant at Lattes and the discharge at Thot. The hydrodynamic pattern in the system has so far been completed for three different meteorological situations: (1) no wind, (2) a steady 6 m/sec wind from the land, and (3) a steady 6 m/sec wind from the sea. These conditions are representative of about 20% of summer weather. For each situation and for each possible effluent, an 'influence ratio', defined as the ratio of a point concentration to the source concentration, has been computed in each part of the system. The completed model constitutes a valuable tool for the optimization of environmental protection in the management of complex lagoon systems. (King-PTT)
W91-07529

CONTENTS OF METALS AND SUSPENDED SOLIDS IN THE RHINE, PART III (METALLGEHALT UND SCHWEBSTOFFGEHALT IM RHEIN III).
BASF A.G., Ludwigshafen am Rhein (Germany, F.R.).
K. G. Malle.
Zeitschrift fuer Wasser- und Abwasser-Forschung ZWABAQ, Vol. 23, No. 5, p 204-208, October 1990, 2 fig, 8 tab, 16 ref.

Descriptors: *Heavy metals, *Rhine River, *Stream pollution, *Suspended solids, *Water pollution sources, *Water quality trends, Analytical methods, Detection limits, Industrial wastes, Nonpoint pollution sources, Wastewater outfall, Water pollution control.

The load of dissolved and suspended heavy metals carried by the River Rhine and its tributaries has three main constituents: (1) a natural background load of geogenic origin acquired, for example, by streams which flow through ore deposits; (2) an anthropogenic load from industrial point sources; and (3) a diffuse load, also of anthropogenic origin, from sources such as rain, surface runoff, and the residual load from municipal sewage-plant outfalls. Background pollution of geological origin comprises around 20% of the load of Pb and Zn, more than 20% of the Hg and Cd load, and about 40% of that of Cr and Ni. The diffuse anthropogenic sources are also important Zn, Cd, and Pb contributors. Since the early seventies, heavy metal concentrations in the Rhine have gone down considerably. Point-source origins, especially, have become less important. In some cases, the analytical procedures for determining metals are no longer sensitive enough to measure their very low concentrations. (King-PTT)
W91-07547

SURVIVAL AND DEGRADATIVE CAPACITY OF PSEUDOMONAS PUTIDA INDUCED OR CONSTITUTIVELY EXPRESSING PLASMID-MEDIATED DEGRADATION OF 2,4-DICHLOROPHENOXYACETATE (TFD) IN SOIL.
Corvallis Environmental Research Lab., OR.
K. A. Short, R. J. Seidler, and R. H. Olsen.
Canadian Journal of Microbiology CJMIAZ, Vol. 36, No. 12, p 821-826, December 1990. 3 fig, 1 tab, 31 ref. EPA Cooperative Agreement No. CR81267901-4.

Descriptors: *Biodegradation, *Fate of pollutants, *Herbicides, *Plasmids, *Pseudomonas, *Soil bacteria, Bacterial physiology, Genetic engineering, Germination, Microbial degradation, Organochlorine pesticides, Pesticides residues.

The survival of genetically altered Pseudomonas putida strains harboring an inducible plasmid, pRO101, or a constitutive plasmid, pRO103, was compared. These plasmids encode for the degradation of 2-4-dichlorophenoxyacetate (TFD) to 2-chloromaleylacetate, and the maintenance of either plasmid did not alter survival of P. putida PPO301(pRO101) or PPO301(pRO103) in an unamended agricultural soil. Moreover, in TFD-amended soil, survival of PPO301, PPO301(pRO101), and PPO301(pRO103) was statistically the same after 50m days. Reapplication of TFD to soil 50 days after the original application did not change the numbers of PPO301(pRO101) or PPO301(pRO103), which cannot use TFD as a sole source of carbon. However, a mutant strain, PPO301KS(pRO101), which is able to use TFD as a sole source of carbon, was stimulated by the second addition of TFD: PPO301KS(pRO101) cfu/g soil increased by greater than 20-fold. Although the microbiota indigenous to the study of the soil was capable of degrading TFD, the addition of plasmid-bearing PPO301 had a dramatic effect on TFD degradation. After 10 days, the concentration of TFD in soil inoculated with plasmid-bearing PPO301 was approximately five times lower (84 ppm) than that in uninoculated soil (435 ppm). In a parallel study, Raphanus sativus (radish) seeds failed to germinate in uninoculated and PPO301-inoculated soil amended with 500 ppm TFD. Seed germination was 53 and 80% in soils inoculated with PPO301(pRO101) and PP401(pRO103), respectively ($p < 0.001$). However, the difference in the rate of TFD degradation between the native soil and soil inoculated with plasmid-bearing P. putida was probably related to the relatively high inoculum density of P. putida strains (10 million cfu) and the relatively low population density of TFD metabolizers indigenous to the soil. (Author's abstract)
W91-07562

ANTIBIOTIC RESISTANCE INDEXING OF ESCHERICHIA COLI TO IDENTIFY SOURCES OF FECAL CONTAMINATION IN WATER.
Maryland Univ., College Park. Dept. of Microbiology.
C. W. Kaspar, J. L. Burgess, I. T. Knight, and R. R. Colwell.
Canadian Journal of Microbiology CJMIAZ, Vol. 36, No. 12, p 891-894, December 1990. 3 tab, 14 ref.

Descriptors: *Bioindicators, *Chesapeake Bay, *Escherichia coli, *Multiple antibiotic resistance, *Pollutant identification, *Water pollution sources, *Water quality standards, Bioassay, Feces, Pollution index, Rural areas, Urban areas.

E. coli, an inhabitant of the intestinal tract of warm-blooded animals, is routinely employed as an indicator of fecal contamination. Multiple antibiotic resistance (MAR) indexing has been used to differentiate E. coli of high risk origin (human, poultry, and swine) from those of other sources. The ability to identify E. coli from high-risk sources of contamination in water could be useful in establishing standards, and facilitate detection of sources of contamination. To determine if MAR profiles would be of value in water analysis, the frequencies of resistant E. coli in water samples collected at urban and rural sites in the Chesapeake Bay were compared. A total of 201 E. coli isolates from urban and rural water were tested with 11 antibiotics to assess the prevalence of antibiotic resistance from each source. Urban waters harbored higher percentages of resistant E. coli strains than rural waters. Antibiotic-resistant E. coli may therefore offer an index of water quality related to source. (Medina-PTT)
W91-07564

ACCUMULATION, DISTRIBUTION AND DEPURATION OF MERCURY IN THE GREEN MUSSEL PERNA VIRIDIS (LINNEAUS).
Cochin Univ. (India). Dept. of Marine Sciences.
P. K. Krishnakumar, R. Damodaran, and P. N. K. Nambisan.
Proceedings of the Indian Academy of Sciences (Animal Sciences) PIANDR, Vol. 99, No. 4, p 345-352, 1990. 2 fig, 1 tab, 29 ref.

Descriptors: *Bioaccumulation, *Marine pollution, *Mercury, *Path of pollutants, *Sea mussels, *Toxicology, Animal tissues, Depuration, Gills, Heavy metals, Muscle, Viscera.

The accumulation, distribution, depuration and biological half-lives of mercury in the gills, viscera, mantle and adductor muscle plus foot of P. viridis were studied. Although mussels can obtain mercury from both seawater and food, only accumulation from seawater was considered here. Mussels were exposed to 37.5 and 75 mg/L mercury as HgCl-2 in a static system for 4 days. The rate of accumulation was maximum in gills followed by viscera, mantle and muscle plus foot. Exposed mussels were then transferred to clean seawater in a flow-through system and maintained for 25 days to study the depuration and biological half-lives (TB/2) of mercury in the different body parts. After 25 days, mercury loss from the external tissues like gills and mantle was faster than from the internal tissues such as viscera and muscle. Gills and mantle showed comparatively shorter TB/2 than the viscera and muscle plus foot. (Author's abstract)
W91-07573

PARAMETER ESTIMATION FOR SIMULATING BINARY HOMOVALENT CATION TRANSPORT IN AGGREGATED SOILS AT VARIABLE IONIC STRENGTH.
Eidgenoessische Technische Hochschule, Zurich (Switzerland). Lab. of Soil Physics.
R. Schulin, A. Papritz, H. Fluhler, and H. M. Selim.

Journal of Contaminant Hydrology JCOHE6, Vol. 7, No. 1/2, p 1-19, January 1991. 6 fig, 7 tab, 17 ref.

Descriptors: *Aeration zone, *Cation exchange, *Ion exchange, *Model studies, *Parameter estimation, *Path of pollutants, *Soil aggregates, *Soil contamination, *Solute transport, Calcium, Forest soils, Magnesium, Switzerland.

Ion exchange is one of the most important reactions governing transport of charged chemical species through the soil profile. Cation transport through ion-exchanging aggregated soils has been modeled by one-region and two-region models. These two models were compared using data from a 1989 study of calcium-magnesium exchange in batch and column experiments with soil aggregates of two Swiss forest soils. It was found that miscible displacement of calcium by magnesium in the column experiments with aggregate packings was fairly well described by the classical convection-dispersion transport model combined with an equilibrium ion-exchange isotherm (one-region model) when the model was fitted to the experimental breakthrough curves. Goodness of fit was not significantly better when a two-region model with first-order mass-transfer kinetics between mobile and immobile regions was used instead of the one-region model. Model calculations using independently determined ion-exchange and transport parameter values resulted in good predictions of the early phases of experimental breakthrough curves but did not adequately account for the tailing behavior during later phases. In another approach, parameters were calibrated by fitting the models to the first of two subsequent breakthrough steps of the experimental effluent curves. Extrapolation of the calibrated models to the second breakthrough step then resulted in improved predictions of the second breakthrough step. However, neither of the two models fully accounted for the immediate reaction of the effluent concentrations upon the second input step. In addition to classical ion-exchange processes, other cation retention and release mechanisms may have been involved in the observed transport behavior. These processes, not yet identified, appear to be effective on larger time scales than those of batch experiments and upon changes in the total ionic strength. (Author's abstract)
W91-07580

ION CHROMATOGRAPHY OF FRESH AND SALT-WATER DISPLACEMENT: LABORATORY EXPERIMENTS AND MULTICOMPONENT TRANSPORT MODELLING.

Vrije Univ., Amsterdam (Netherlands). Inst. voor Aardwetenschappen.
H. E. Beekman, and C. A. J. Appelo.
Journal of Contaminant Hydrology JCOHE6, Vol. 7, No. 1/2, p 21-37, January 1991. 5 fig, 5 tab, 19 ref.

Descriptors: *Cation exchange, *Geochemistry, *Groundwater chemistry, *Ion exchange chromatography, *Model studies, *Saline-freshwater interfaces, Calcium, Dispersivity, Groundwater transport, Magnesium, Saline water intrusion, Sodium, Solute transport.

Buffering reactions between sediment and groundwater occur if amounts of exchangeable cations are relatively high compared to concentrations in water. Characteristic concentrations of elements develop in both time and space during dispersive displacement of fresh and salt water as a result of cation exchange, and may be used for (frontal) analyses of salt water percolation. Column experiments with fresh and salt water displacements were performed to obtain information on multicomponent ion exchange at varying concentration levels as well as to validate a multicomponent transport model. During salt water displacement by fresh groundwater, a three times larger dispersivity was observed in the interface than for the reverse situation. Experiments with synthetic solutions with varying Ca/Na ratios indicate that solution density differences and chemical interaction between displacing solution and exchange complex determine the change in dispersivity. Using calculated selectivity coefficients, covering a broad composition range, and dispersivity values as input, a geochemical mixing cell model was applied to simulate the displacement experiments. The results show that fresh water displacement by once diluted seawater can only be modeled when the Gapon selectivity of Ca over Mg decreases by a factor of two during the breakthrough. (Author's abstract)
W91-07581

LENGTH SCALES OF CONVECTION-DISPERSION APPROACHES TO FLOW AND TRANSPORT IN POROUS MEDIA.

Rutgers - The State Univ., New Brunswick, NJ. Dept. of Soils and Crops.
P. F. Germann.
Journal of Contaminant Hydrology JCOHE6, Vol. 7, No. 1/2, p 39-49, January 1991. 3 fig, 25 ref.

Descriptors: *Convection, *Dispersion, *Flow equations, *Groundwater movement, *Path of pollutants, *Porous media, *Soil water, *Solute transport, Aeration zone, Hydrodynamics, Model studies, Saturated soils.

A lot of effort has been spent in the past to relate the flow and transport properties of porous media containing macropores, fissures, or cracks to their morphological descriptions. However, due to the many shapes and geometrical extents of these preferred flow paths, it is not possible at present to deduce flow and transport properties from their morphology. An alternate way of deciding when convection-dispersion equations (CDEs) adequately deal with flow and transport in porous media or when other approaches have to be applied is to interpret the results of these processes. However, some very general experimental criteria have to be met for the applicability of CDEs. Two length scales of one-dimensional transient flow and transport in porous media have been proposed: the minimum mixing length, also referred to as Lagrangean length scale, and the width of hydrodynamic spread. The macroscopic path length in the medium causing hydrodynamic dispersion has to exceed markedly both the minimum mixing length and the width of hydrodynamic spread if the parameters derived from the application of CDEs should be of predictive value. Since a solute must have had the chance to fully disperse before the commonly used CDEs can be applied, it follows that the so-called column Peclet number has to exceed 32. Many inferences to the need for more sophisticated transport models from experiments not meeting this requirement have to be reconsidered. The fact that the length scales for the dispersion of soil moisture differ from those for the dispersion of potential energy close to saturation is regarded as a soil hydrologic challenge. (Fish-PTT)
W91-07582

STATISTICAL AND GRAPHICAL METHODS FOR EVALUATING SOLUTE TRANSPORT MODELS: OVERVIEW AND APPLICATION.

California Univ., Berkeley. Dept. of Soil Science.
K. Loague, and R. E. Green.
Journal of Contaminant Hydrology JCOHE6, Vol. 7, No. 1/2, p 51-73, January 1991. 7 fig, 5 tab, 20 ref.

Descriptors: *Groundwater movement, *Groundwater pollution, *Mathematical models, *Model studies, *Model testing, *Path of pollutants, *Solute transport, Georgia, Graphical analysis, Leaching, Performance evaluation, Pesticides, Soil water, Statistical analysis.

Mathematical modeling is the major tool to predict the mobility and the persistence of pollutants to and within groundwater systems. Several comprehensive institutional models have been developed in recent years for this purpose. However, evaluation procedures are not well established for models of saturated-unsaturated soil water flow and chemical transport. A physically-based model of solute transport is one that is based upon the coupled partial differential equations that describe the processes of interest. Coupled soil water flow and solute transport are simulated by sequential solution using numerical techniques given the appropriate initial conditions, boundary conditions, and parameter values. Complete model evaluation requires both operational and scientific examination. The operational component of model evaluation is the assessment of accuracy and precision; the scientific component is the assessment of consistency between model-predicted results and the prevailing scientific theory. Evaluation of model performance should include both statistical criteria and graphical displays, and can be useful for making comparative evaluations of model performance between alternative/competing models. An example of model evaluation for a mathematical model of pesticide leaching (the EPA pesticide root zone model PRZM) used observed and predicted atrazine concentration profiles from a small catchment in Georgia. It was shown that, although concentration profiles are useful, they do not fully evaluate model performance. Taken independently each validation method can be limited by stringent assumptions, i.e. independence, equality of variance, and normality. If one or more assumption is violated then sole reliance on the method is suspect. A model should be considered validated only if a set of performance tests are met. (Fish-PTT)
W91-07583

DETERMINISTIC AND STOCHASTIC MODELING OF REACTIVE SOLUTE TRANSPORT.

Agricultural Univ., Wageningen (Netherlands). Dept. of Soil Science and Plant Nutrition.
S. E. A. T. M. van der Zee, and G. H. Bolt.
Journal of Contaminant Hydrology JCOHE6, Vol. 7, No. 1/2, p 75-93, January 1991. 7 fig, 3 tab, 19 ref.

Descriptors: *Model studies, *Model testing, *Path of pollutants, *Soil contamination, *Soil water, *Solute transport, *Sorption, Groundwater movement, Parameter estimation, Soil columns, Soil solution.

One of the main problems in modeling field-scale transport of solutes subject to considerable immobilization reactions in soil is the validation of the model. This is caused by the large values of the retardation factor resulting from these reactions. A sorption model for a solute (orthophosphate, denoted by P) subject to strong retardation has been developed along with appropriate assessment of parameters. For validation, P transport in small columns was predicted and compared with breakthrough data with reasonable to good results. The validated sorption model was used for predictions of P transport in a column under field conditions. At relatively small flow velocities P tended to move through soil in a relatively sharp front. Due to spatial variability it was not justified to take displacement in a single column as the point of departure for the evaluation of transport in a field. To deal with spatial variability of sorption parameters and solute input a probabilistic approach was used. With an approximate analytical solution, spatial variability was shown to have a large effect on transport in the case of continuous solute input. Monte Carlo simulations showed that this was also the case for pulse-type input conditions. (Author's abstract)
W91-07584

CONDITIONAL SIMULATION OF FLOW AND TRANSPORT.

Science and Education Administration, University Park, PA. Northeast Watershed Research Center.
A. S. Rogowski, J. K. Wolf, and D. E. Simmons.
Journal of Contaminant Hydrology JCOHE6, Vol. 7, No. 1/2, p 95-121, January 1991. 10 fig, 6 tab, 18 ref. EPA Interagency Agreement No. DW129-303-03-01-0 with USDA.

Descriptors: *Aeration zone, *Groundwater pollution, *Infiltration, *Model studies, *Path of pollutants, *Soil water, *Solute transport, Clays, Hydraulic conductivity, Infiltrometers, Leachates, Soil solution.

To successfully model groundwater pollution, it is necessary to either measure or estimate parameters pertaining to flow and transport in the vadose zone. Since these parameters usually vary in space, their distributions on a scale of a site to be modeled

are of interest. Leachate and outflow from below a compacted layer of clay subsoil were sampled and compared with conditionally simulated flux based on standard methods and 1:1 soil-water extracts. Results showed that conditional simulations of flux distribution based on laboratory values of hydraulic conductivity severely underestimated the observed outflow while those for other methods except the Double Ring infiltrometer and Water Breakthrough tended to overestimate. While point-to-point correspondence was poor, rank-to-rank comparisons of most simulated distributions differed from observed only by a factor. Water quality of leachate at 12 months and 1:1 extracts of cores compared best when total loads rather than concentrations were considered. Results suggest that Double Ring infiltration measurements and Breakthrough data as well as total chemical loads predicted by 1:1 soil-water extracts could be used to simulate spatially distributed flux and outflow quality from below a compacted clay layer. This technology is believed to be transferable to actual field soils, though response times are likely to be shorter. Thus similar methods can be used to provide flux and outflow quality at the root zone leading to better estimates of recharge. Because of the favorable geologic and hydrologic setting the results are most likely to apply in the humid northeastern U.S. (Fish-PTT)
W91-07585

TOWARD VALIDATING STATE-DEPENDENT MACROSCOPIC ANISOTROPY IN UNSATURATED MEDIA: FIELD EXPERIMENTS AND MODELING CONSIDERATIONS.
Washington State Univ., Pullman. Dept. of Civil and Environmental Engineering.
J. T. McCord, D. B. Stephens, and J. L. Wilson.
Journal of Contaminant Hydrology JCOHE6, Vol. 7, No. 1/2, p 145-175, January 1991. 16 fig, 3 tab, 27 ref. United States Geological Survey, U.S. Department of the Interior Matching Grant No. 1-4-23660.

Descriptors: *Aeration zone, *Anisotropy, *Model studies, *Soil solution, *Soil water, *Solute transport, *Unsaturated flow, Dunes, Flow characteristics, Flow equations, Hydraulic conductivity, Hysteresis, Porous media, Sand, Saturated flow, Tracers.

Methods of analysis which are used to investigate flow and transport through unsaturated soils range from field and laboratory experimentation to mathematical and chemical modeling. However, there is some question as to the validity of past approaches to handling anisotropy in variably saturated flow models. A series of detailed soil-water tracer experiments was conducted in a natural landscape to examine possible approaches to modeling the observed flow and transport. The experiments, conducted on a sand dune, indicated that significant horizontal downslope flow components develop despite the presence of near-vertical downward hydraulic gradient. This suggests that under in situ pressure heads (-30 to -70 cm) the dune sands behave as a highly anisotropic medium. Field and laboratory permeameter analyses show that the sands are nearly isotropic at complete saturation. These field and laboratory experiments provide supporting evidence for theoretical and experimental postulations that anisotropy in the hydraulic conductivity of unsaturated heterogeneous porous media varies as the state (capillary pressure head, head gradient, saturation, etc.) of the media varies. In addition, a simple scenario was developed to show how hysteresis-enhanced moisture content variations can cause a texturally homogeneous porous medium profile to behave anisotropically under transient unsaturated conditions. It is recognized that both layered heterogeneity and hysteresis-enhanced moisture content variations contribute to the anisotropic behavior observed in the tracer experiments, but the relative magnitude of their contributions were not quantified. However, a simple procedure can incorporate variable anisotropy into a predictive numerical model. (Fish-PTT)
W91-07587

COMPARISON OF URBAN AND SUBURBAN PRECIPITATION CHEMISTRY.
Argonne National Lab., IL. Environmental Research Div.
For primary bibliographic entry see Field 2B.
W91-07613

GEOGRAPHIC INFORMATION SYSTEMS AND NON-POINT SOURCE WATER QUALITY AND QUANTITY MODELLING.
Oklahoma Univ., Norman. School of Civil Engineering and Environmental Science.
For primary bibliographic entry see Field 7C.
W91-07621

KINETICS OF CHLORINATED HYDROCARBON DEGRADATION BY METHYLOSINUS TRICHOSPORIUM OB3B AND TOXICITY OF TRICHLOROETHYLENE.
Groningen Rijksuniversiteit (Netherlands). Dept. of Biochemistry.
R. Oldenhuis, J. Y. Oedzes, J. J. van der Waarde, and D. B. Janssen.
Applied and Environmental Microbiology AEMIDF, Vol. 57, No. 1, p 7-14, January 1991, 6 fig, 1 tab, 41 ref.

Descriptors: *Biodegradation, *Chlorinated hydrocarbons, *Cleanup, *Dechlorination, *Fate of pollutants, *Methane bacteria, *Microbial degradation, *Trichloroethylene, Carbon radioisotopes, Culturing techniques, Degradation products, Kinetics.

The degradation kinetics of trichloroethylene (TCE) and seven other chlorinated aliphatic hydrocarbons were estimated using a jacketed elimination vessel (JEV) containing whole cells of M. trichosporium grown under copper stress by cultivation in a batch culture containing 0.07 micromoles of copper, which enhances production of soluble methane monooxygenase (sMMO). This enzyme has been demonstrated to be capable of degrading TCE. Compounds that readily degraded included chloroform, trans-1,2-dichloroethylene, and trichloroethylene (TCE) with V-max values of 550, 330, and 290 nanomoles per minute per mg of cells, respectively. 1,1-Dichloroethylene was found to be a very poor substrate, while TCE and its conversion products were found to be toxic to cells. The degree of inactivation was proportional to the amount of TCE degraded, with maximum degradation occurring at a concentration of 2 micro-moles of TCE per mg of cells. The addition of activated carbon decreased the acute toxicity of high levels of TCE and slow desorption enabled the cells to partially degrade TCE. During the conversion of C-14 tagged TCE, various proteins became radiolabeled, including the alpha subunit of the hydroxylase component of sMMO. This indicates that TCE-mediated inactivation of cells was caused by nonspecific covalent binding of degradation products to cellular proteins. These degradation products include TCE epoxides, or acylchlorides produced after hydrolysis by a sMMO component. (Doyle-PTT)
W91-07640

AEROBIC BIODEGRADATION POTENTIAL OF SUBSURFACE MICROORGANISMS FROM JET FUEL-CONTAMINATED AQUIFER.
Geological Survey, Columbia, SC.
C. M. Aelion, and P. M. Bradley.
Applied and Environmental Microbiology AEMIDF, Vol. 57, No. 1, p 57-63, January 1991, 7 fig, 4 tab, 22 ref.

Descriptors: *Aerobic bacteria, *Aquifers, *Biodegradation, *Bioremediation, *Cleanup, *Fate of pollutants, *Groundwater pollution, Carbon radioisotopes, Enrichment, Fuel, Gas chromatography, Hydrocarbons, Microbial studies, Sediment contamination, South Carolina.

In 1975, a leak of 83,000 gallons (314,189 liters) of jet fuel (JP-4) contaminated a shallow water-table aquifer near North Charleston, S.C. Laboratory experiments were conducted with contaminated sediments to assess the aerobic biodegradation potential of the in situ microbial community. The sediments were incubated with C-14 labeled organic compounds, and the evolution of C-14 CO2 was measured over time. Gas chromatographic analyses were used to monitor CO2 production and O2 consumption under aerobic conditions. Results indicated that the microbes from contaminated sediments remained active despite the potentially toxic effects of JP-4. C-14 CO2 was measured from C-14 glucose respiration in unamended and nitrate-amended samples after 1-day of incubation. Total C-14 glucose metabolism was greater in 1mM nitrate-amended than in unamended samples because of increased cellular incorporation of the C-14 label. C-14 benzene and C-14 toluene were not significantly respired after 3 months of incubation. With the addition of 1 mM NO3, CO2 production measured by gas chromatographic analysis increased linearly during 2 months of incubation at a rate of 0.099 micromole per gram (dry weight) per day while oxygen concentration decreased at a rate of 0.124 micromole per gram (dw) per day. With no added nitrate, CO2 production was not different from that in metabolically inhibited control vials. From the examination of selected components of JP-4, the n-alkane hexane appeared to be degraded as opposed to the branched alkanes of similar molecular weight. The results suggest that the in situ microbial community is active despite JP-4 contamination and that biodegradation may be compound specific. Also, the community is strongly nitrogen limited, and nitrogen additions may be required to significantly enhance hydrocarbon biodegradation. (Author's abstract)
W91-07641

DECHLORINATION OF CHLOROCATECHOLS BY STABLE ENRICHMENT CULTURES OF ANAEROBIC BACTERIA.
Swedish Environmental Research Inst., Stockholm.
A. Allard, P. Hynning, C. Lindgren, M. Remberger, and A. H. Neilson.
Applied and Environmental Microbiology AEMIDF, Vol. 57, No. 1, p 77-84, January 1991, 5 fig, 2 tab, 30 ref.

Descriptors: *Anaerobic bacteria, *Biodegradation, *Cleanup, *Culturing techniques, *Dechlorination, *Fate of pollutants, Chlorinated hydrocarbons, Degradation products, Laboratory methods, Mixed cultures, Sediment contamination.

Metabolically stable anaerobic cultures obtained by enrichment with 5-bromovanillin, 5-chlorovanillin, catechin, and phloroglucinol were used to study dechlorination of chlorocatechols. A high degree of specificity in dechlorination was observed, and some chlorocatechols were appreciably more resistant than others: only 3,5-dichlorocatechol, 4,5-dichlorocatectol, 3,4,5-trichlorocatechol and tetrachlorocatechol were dechlorinated, and not all of them were dechlorinated by the same consortium. 3,5-Dichlorocatechol produced 3-chlorocatechol, 4,5-dichlorocatechol produced 4-chlorocatechol, and 3,4,5-trichlorocatechol produced either 3,5-dichlorocatechol or 3,4-dichlorocatechol; tetrachlorocatechol produced only 3,4,6-trichlorocatechol. Incubation of uncontaminated sediments without additional carbon sources brought about dechlorination of 3,4,5-trichlorocatechol to 3,5-dichlorocatechol. O-demethylation of chloroguaiacols was generally accomplished by enrichment cultures, except that catechin enrichment was unable to O-demethylate tetraoguaiacol. None of the enrichments dechlorinated any of the polychlorinated phenols examined. The results suggested that dechlorination was not dependent on enrichment with or growth at the expense of chlorinated compounds and that it would be premature to formulate general rules for the structural dependence of the dechlorination reaction. (Author's abstract)
W91-07642

METHYLMERCURY DECOMPOSITION IN SEDIMENTS AND BACTERIAL CULTURES: INVOLVEMENT OF METHANOGENS AND SULFATE REDUCERS IN OXIDATIVE DEMETHYLATION.
Geological Survey, Menlo Park, CA.
R. S. Oremland, C. W. Culbertson, and M. R. Winfrey.

Applied and Environmental Microbiology AEMIDF, Vol. 57, No. 1, p 130-137, January 1991, 3 fig, 6 tab, 39 ref.

Descriptors: *Biodegradation, *Fate of pollutants, *Mercury, *Methane bacteria, *Methylmercury, *Path of pollutants, Aerobic bacteria, Anaerobic bacteria, Carbon radioisotopes, Culturing techniques, Degradation products, Enzymes, Estuarine sediments, Freshwater sediments, Sediment contamination.

Demethylation of monomethylmercury in freshwater and estuarine sediments and in bacterial cultures was investigated with C-14 labeled CH3HgI. Under anaerobiosis, results with inhibitors indicated partial involvement of both sulfate reducers and methanogens, the former dominating estuarine sediments, while both were active in freshwaters. Aerobes were the most significant demethylators in estuarine sediments, but were unimportant in freshwater sediments. Products of anaerobic demethylation were mainly C-14 CO2 as well as lesser amounts of C-14 CH4. Acetogenic activity resulted in fixation of some C-14 CO2 produced from C-14 CH3HgI into acetate. Aerobic demethylation in estuarine sediments produced only C-14 CH4, while aerobic demethylation in freshwater sediments produced small amounts of both C-14 CH4 and C-14 CO2. Two species of Desulfovibrio produced only traces of C-14 CH4 from C-14 CH3HgI, while a culture of a methylotrophic methanogen formed traces of C-14 CO2 and C-14 CH4 when grown on trimethylamine in the presence of C-14 CH3HgI. These results indicate that both aerobes and anaerobes demethylate mercury in sediments, and that either group may dominate in a particular sediment type. Aerobic demethylation in the estuarine sediments appeared to proceed by the previously characterized organomercurial-lyase pathway, because methane was the sole product. However, aerobic demethylation in freshwater sediments as well as anaerobic demethylation in all sediments studied produced primarily carbon dioxide. This indicates the presence of an oxidative pathway, possibly one in which methylmercury serves as an analog of one-carbon substrates. (Author's abstract)
W91-07643

COMETABOLISM OF 3,4-DICHLOROBENZOATE BY ACINETOBACTER SP. STRAIN 4-CB1.
California Univ., Riverside. Dept. of Soil and Environmental Sciences.
P. Adriaens, and D. D. Focht.
Applied and Environmental Microbiology AEMIDF, Vol. 57, No. 1, p 173-179, January 1991, 5 fig, 4 tab, 43 ref.

Descriptors: *Acinetobacter, *Biodegradation, *Dechlorination, *Fate of pollutants, Biotransformation, Chlorinated hydrocarbons, Culturing techniques, Degradation products, Enzymes, Substrates.

When Acinetobacter strain 4-CB1 was grown on 4-chlorobenzoate (4-CB), it cometabolized 3,4-dichlorobezoate (3,4-DCB) to 3-chloro-4-hydroxybenzoate (3-C-4OHB), which could be used as a growth substrate. No cometabolism of 3,4-DCB was observed when Acinetobacter sp. strain 4-CB1 was grown on benzoate. 4-Carboxy-1,2-benzoquinone was formed as an intermediate form from 3,4-DCB and 3-C-4-OHB in aerobic and anaerobic resting-cell incubations and was the major transient intermediate found when cells were grown on 3-C-4-OHB. The first dechlorination step of 3,4-DCB was catalyzed by the 4-CB dehalogenase, while a soluble dehalogenase was responsible for dechlorination of 3-C-4-OHB. Both enzymes were inducible by the respective chlorinated substrates, as indicated by oxygen uptake experiments. The dehalogenase activity on 3-C-4-OHB, observed in crude cell extracts, was 109 and 44 nanomole of 3-C-4-OHB per minute per mg of protein under anaerobic and aerobic conditions, respectively. 3-Chloro-4-hydroxybenzoate served as a pseudosubstrate for the 4-hydroxybenzoate monooxygenase by affecting oxygen and NADH consumption without being hydroxylated. Contrary to 4-CB metabolism, the results suggest that 3-C-4-OHB was not metabolized via the protocatechuate pathway. Despite the ability of resting cells grown on 4-CB or 3-C-4-OHB to carry out all of the necessary steps for dehalogenation and catabolism of 3,4-DCB, it appeared that 3,4-DCB was unable to induce the necessary 4-CB dehalogenase for the initial para-dehalogenation step. Since this degradation mechanism follows a cometabolic-catabolic sequence, it is distinguished from the classic definition of cometabolism in which no nutritional benefit is derived by the organism. (Author's abstract)
W91-07644

MOBILIZATION OF GENETICALLY ENGINEERED PLASMID PHSV106 FROM ESCHERICHIA COLI HB101(PHSV106) TO ENTEROBACTER CLOACAE IN DRINKING WATER.
Delaware Univ., Newark. School of Life and Health Sciences.
For primary bibliographic entry see Field 5F.
W91-07645

EFFECTS OF TOXICITY, AERATION, AND REDUCTANT SUPPLY ON TRICHLOROETHYLENE TRANSFORMATION BY A MIXED METHANOTROPHIC CULTURE.
California Univ., Berkeley. Dept. of Civil Engineering.
L. Alvarez-Cohen, and P. L. McCarty.
Applied and Environmental Microbiology AEMIDF, Vol. 57, No. 1, p 228-235, January 1991, 9 fig, 2 tab, 37 ref. Environmental Protection Agency, Western Region Hazardous Substance Research Center, agreement R-815738.

Descriptors: *Biodegradation, *Chlorinated hydrocarbons, *Cleanup, *Culturing techniques, *Fate of pollutants, *Methane bacteria, *Microbial degradation, *Trichloroethylene, Aerobic conditions, Anoxic conditions, Biotransformation, Degradation products, Methane, Toxicity.

Methanotrophic cultures have the potential for high trichloroethylene (TCE) transformation, because they produce the enzyme, methane monooxygenase (MMO), which is responsible for both methane oxidation and TCE epoxidation. The rate and capacity of a mixed methanotrophic culture at room temperature were measured to determine the effects of time without methane (resting), use of an alternative energy source (formate), aeration, and toxicity of TCE and its transformation products. The initial specific TCE transformation rate of resting cells was 0.6 mg of TCE per mg of cells per day, and they had a finite TCE transformation capacity of 0.036 mg of TCE per mg of cells. Formate addition resulted in increased initial specific TCE transformation rates (2.1 mg/mg of cells per day) and elevated transformation capacity (0.073 mg of TCE per mg of cells). Significant declines in methane conversion rates following exposure to TCE were observed for both resting and formate fed cells, suggesting toxic effects caused by TCE or its transformation products. TCE transformation and methane consumption rates of resting cells decreased with time much more rapidly when cells were shaken and aerated than when they remained dormant, suggesting that the transformation ability of methanotrophs is best preserved by storage under anoxic conditions. (Doyle-PTT)
W91-07646

INFLUENCE OF ENDOGENOUS AND EXOGENOUS ELECTRON DONORS AND TRICHLOROETHYLENE OXIDATION TOXICITY ON TRICHLOROETHYLENE OXIDATION BY METHANOTROPHIC CULTURES FROM A GROUNDWATER AQUIFER.
Stanford Univ., CA. Dept. of Civil Engineering.
S. M. Henry, and D. Grbic-Galic.
Applied and Environmental Microbiology AEMIDF, Vol. 57, No. 1, p 236-244, February 1991, 4 fig, 2 tab, 46 ref. EPA Grants No. CR 812220 and R815738-01-OCS.

Descriptors: *Biodegradation, *Cleanup, *Culturing techniques, *Fate of pollutants, *Trichloroethylene, Aquifers, Bacteria, Biotransformation, Dechlorination, Degradation products, Groundwater, Methane bacteria, Microbial studies.

Catabolic oxygenases such as methane monooxygenase require electrons (reducing power) to carry out their catabolic function. During growth on methane, reducing power is regenerated by the mineralization of methane to CO2. However during the oxidation of a cometabolite such as trichloroethylene (TCE), the reductant supply is not regenerated. TCE-transforming aquifer methanotrophs were evaluated for the influence of TCE oxidation toxicity and the effect of reductant availability on TCE transformation rates during methane starvation. TCE oxidation at relatively low (6 mg/L) TCE concentrations significantly reduced subsequent methane utilization in the mixed and pure cultures tested and reduced the number of viable cells in the pure culture. Methylomonas strain MM2 by an order of magnitude. Perchloroethylene, tested at the same concentration, had no effect on the cultures. Neither the TCE itself nor the aqueous intermediates were responsible for the toxic effect, and it is suggested that TCE oxidation toxicity may have resulted from reactive intermediates that attacked cellular macromolecules. During starvation, all methanotrophs tested exhibited a decline in TCE transformation rates, and this decline followed exponential decay. Formate, provided as an exogenous electron donor, increased TCE transformation rates in Methylomonas strain MM2, but not in mixed culture MM1 or unidentified isolate, CSC-1. Mixed culture MM2 did not transform TCE after 15 h of starvation, but mixed cultures MM1 and MM3 did. The methanotrophs in mixed cultures MM1 and MM3, and the unidentified isolate CSC-1 that was isolated from mixed culture MM1 contained lipid inclusions, whereas the methanotrophs of mixed culture MM2 and Methylomonas strain MM2 did not. It is proposed that lipid storage granules serve as an endogenous source of electrons for TCE oxidation during methane starvation. (Doyle-PTT)
W91-07647

DEGRADATION OF TOLUENE AND M-XYLENE AND TRANSFORMATION OF O-XYLENE BY DENITRIFYING ENRICHMENT CULTURES.
New York Univ. Medical Center, NY. Dept. of Microbiology.
For primary bibliographic entry see Field 5G.
W91-07652

IN SITU BACTERIAL SELENATE REDUCTION IN THE AGRICULTURAL DRAINAGE SYSTEMS OF WESTERN NEVADA.
Geological Survey, Menlo Park, CA.
R. S. Oremland, N. A. Steinberg, T. S. Presser, and L. G. Miller.
Applied and Environmental Microbiology AEMIDF, Vol. 57, No. 1, p 615-617, February 1991, 1 fig, 1 tab, 9 ref.

Descriptors: *Agricultural water, *Biodegradation, *Drainage water, *Evaporation ponds, *Fate of pollutants, *Nevada, *Path of pollutants, *Selenium, Agricultural chemicals, Atomic absorption spectroscopy, Groundwater, Hunter Drain, Massie Slough, Sediment contamination, Sediment sampling, Sediments, Soil bacteria, South Lead Lake.

Respiratory reduction of selenate to elemental selenium is a mechanism whereby bacteria in sediments effect removal of this toxicant from overlying waters. This process is an important sink in agricultural evaporation ponds in which selenate is abundant. However, selenium at nanomolar levels still poses a threat to biota. Dissimilatory in situ selenate reduction to elemental selenium in sediments from irrigated agricultural drainage regions of western Nevada was measured at ambient Se oxyanion concentrations. Total dissolved selenium (selenate, senenite, and organoselenium) was determined by atomic absorption spectroscopy. Selenate reduction was rapid, with turnover rate constants ranging from 0.04 to 1.8 per hour at total Se concentrations in pore water of 13 to 455 nanomoles. Estimates of removal rates of selenium oxyanions were 14, 38, and 155 micromoles per sq m per day for South Lead Lake, Massie Slough, and Hunter Drain, respectively. The kinetics of selenate reduction suggest that selenium oxyanion con-

centrations should have rapidly decreased with depth in the sediment. The presence of nitrate and selenate in pore waters of all sites indicate that other hydrologic factors such as input of oxyanions from shallow groundwater comparable to their biological removal rates obliterated any chemical gradients established by biological removal processes. (Doyle-PTT)
W91-07656

BIODEGRADATION OF MORPHOLINE IN RIVER WATER AND ACTIVATED SLUDGE.
Leeds Univ. (England). Dept. of Microbiology.
J. S. Knapp, and A. J. Whytell.
Environmental Pollution ENPOEK, Vol. 68, No. 1/2, p 67-79, 1990, 1 fig, 4 tab, 22 ref.

Descriptors: *Biodegradation, *Fate of pollutants, *Industrial wastes, *Morpholine, *Wastewater treatment, Activated sludge, Hydrocarbons, Microbial degradation, Rivers.

The ability of microorganisms in a wide range of river waters and activated sludges to degrade the heterocyclic compound morpholine was determined by die-away tests and also by most probable number counts of the morpholine degrading microbes. All activated sludges were capable of morpholine degradation but the rate at which degradation occurred could not be related to the type of influent treated. Nearly all river waters contained morpholine degrading microbes which could degrade morpholine in die-away tests. Generally, biodegradation of morpholine occurred more rapidly the further down stream the sample was taken. Morpholine degradation rates could not, however, be related to the immediate severity of pollution (as measured by National Water Council NWC classification) at any sampling site. It may be that morpholine degradation rate is related to the cumulative effect of any particular discharge. Clearly, the capacity to degrade morpholine exists in rivers and activated sludges from sewage works; in practice, however, the rates of degradation observed are very low and it is unlikely that significant morpholine biodegradation generally occurs in these systems. (Author's abstract)
W91-07659

STOCHASTIC ANALYSIS OF SOLUTE MOVEMENT IN COMPACTED SOIL LINERS.
Wisconsin Univ., Madison. Dept. of Civil and Environmental Engineering.
C. H. Benson.
IN: Hazardous and Industrial Wastes: Proceedings of the 22nd Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 195-212. 10 fig, 9 ref. US EPA agreement Cr 0055586-01.

Descriptors: *Hydraulic conductivity, *Landfills, *Liners, *Model studies, *Path of pollutants, *Solute transport, *Wastewater lagoons, Clays, Environmental effects, Hazardous waste disposal, Land disposal, Probabilistic process, Soil water, Stochastic models, Waste disposal.

Compacted soil liners are clayey earthen barriers that are used to mitigate the transport of contaminated liquid from facilities such as hazardous and municipal waste landfills, sewage lagoons, and surface impoundments. The time when the liner first begins to leak, termed the first-passage time, and subsequent flux are difficult to compute because the hydraulic properties of the compacted soil vary irregularly throughout the liner. Because large, irregular fluctuations in hydraulic conductivity cannot be predicted with certainty, stochastic representations of hydraulic conductivity, first-passage time and flux are necessary. Probability theory can be applied to obtain the distributions of the first-passage time and flux in terms of the distribution of hydraulic conductivity. The properties of the convolution integral and the probability integral transform are exploited to obtain these distributions. The first-passage-time distribution is described by the reliability function which yields the probability that the first-passage time is greater than a specified time. A probability density function, that is analogous to a histogram, is used to describe the distribution of flux. A schematic of the soil liner that is described by this model was examined. Based on the results of the model described, the following conclusions were made: Significant reductions in mean hydraulic conductivity yield significant reductions in first-passage time and flux even at large percentiles such as 0.95. Large reductions in the variability of hydraulic conductivity result in only small changes in the extreme values of first-passage time and flux. An increase in the thickness of a soil liner has beneficial effects on the distributions of first-passage time and flux. Effective porosity has a tremendous effect on the first-passage time distribution. (See also W91-07662) (Mertz-PTT)
W91-07676

GROUNDWATER DEGRADATION AT A HAZARDOUS WASTE LANDFILL FROM INADEQUATE WASTE LIQUIDS MANAGEMENT--A CASE HISTORY.
Du Pont Environmental Remediation Services, Aston, PA.
J. M. Connor, and R. D. Buller.
IN: Hazardous and Industrial Wastes: Proceedings of the 22nd Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 213-222. 6 fig.

Descriptors: *Groundwater pollution, *Hazardous wastes, *Landfills, *Path of pollutants, *Pennsylvania, *Waste management, *Water pollution sources, Environmental quality, Geohydrology, Groundwater quality, Land disposal, Leachates, On-site investigations, Resource Conservation and Recovery Act, Waste disposal.

A groundwater quality assessment was conducted at a closed stabilized hazardous waste landfill in Southeastern Pennsylvania in response to evidence that groundwater quality downgradient of the landfill was being impacted by operations at the landfill. The groundwater quality assessment was conducted in accordance with the Resource Conservation and Recovery Act (RCRA) guidelines for groundwater assessment and abatement studies. A primary objective of the assessment was to determine the source of the observed groundwater contamination and determine if the source was still contributing contaminants. Determining the source of the groundwater contamination required analyses of historical activities for each of the operating units at the landfill, historical and current water quality and contaminant plume occurrences, and hydrogeologic conditions at the site. The results of this study document that groundwater contamination detected at this closed hazardous waste landfill was the result of inadequate waste liquids handling in the process water pond and the leachate collection/detection sumps. The closed hazardous waste landfill does not appear to be the source of the observed groundwater contamination. Analysis of the historical operating information documented failures of the process water pond and sumps to contain the waste liquids. The operating history also documented the presence of an intermittent shallow contaminant groundwater in the vicinity of the ponds that disappeared after the cessation of operations or implementation of repairs in these areas. The hydrogeological and water quality information documented the highest levels of groundwater contaminants to be in the vicinity of the waste liquid handling areas. The decreasing concentrations of contaminants in groundwater subsequent to site closure in 1984 supports the conclusion that the landfill was not the source of the contamination. (See also W91-07662) (Mertz-PTT)
W91-07677

EXAMPLE OF USING NCASI PROGRAM RIVER AND FISH IN COMPUTING THE FATE OF DIOXIN IN RECEIVING WATERS.
National Council for Air and Stream Improvement, Medford, MA.
J. J. McKeown, A. Shortelle, P. Anderson, V. Fry, and J. Dudley.
IN: Hazardous and Industrial Wastes: Proceedings of the 22nd Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 223-240. 3 fig, 12 tab, 2 ref.

Descriptors: *Computer models, *Dioxins, *Food chains, *Model studies, *Path of pollutants, *River flow, *Stream pollution, Fish, Organic carbon, Pulp and paper industry, Suspended solids, Tissue analysis.

Two example cases demonstrate the use of the computer models RIVER and FISH, models which were developed to assist the paper industry understand the fate and transport of dioxin in riverine systems. The model RIVER is a dynamic representation of the history of conditions occurring in the receiving stream for a lengthy period of record. Data are needed on flow, total suspended solids, and temperature at all locations of interest in the stream. Data are also needed on the organic carbon fraction of the total suspended solids. Where data are missing, such data needs to be estimated. In addition to data on the receiving river, the procedure requires data on the discharge of dioxin. Program FISH is a compartmentalized estimate of the food chain which exists in rivers. Elements in the food chain begin with first order consumers and end with large fish. For each compartment an estimate of dioxin uptake, dioxin clearance and growth rate is needed along with assimilation efficiency and ration size. Estimates of the key factors are adjusted for water temperature and fish age. The output of FISH provides the average concentration of dioxin in water and in fish in each river reach. The models produce values for whole fish. The data base for whole fish to fillet ratios for dioxin is under development and when available will provide the link between information produced by the model. For the time being, model outputs for fish appear to be in the general range of measured concentrations in fish. A start has been made toward developing a procedure to model fate and transport in the riverine environment. (See also W91-07662) (Mertz-PTT)
W91-07678

CASE HISTORY: MITIGATION OF GASOLINE VAPOR MIGRATION INTO PRIVATE RESIDENCE.
Duffield Associates, Inc., Wilmington, DE.
For primary bibliographic entry see Field 5G.
W91-07682

REMEDIATION OF A CONTAMINATED DRAINAGE DITCH IN PROXIMITY TO AN ACTIVE RAILROAD.
Woodward-Clyde Consultants, Plymouth Meeting, PA.
For primary bibliographic entry see Field 5G.
W91-07684

LEACHATE CHARACTERISTICS FROM INCINERATOR ASH MONOFIL AND LANDFILL FOR ASH-MSW CO-DISPOSAL.
For primary bibliographic entry see Field 5E.
W91-07703

HAZARDOUS WASTE DISPOSAL IN RELATIONSHIP TO RADON GAS EMANATION IN ATMOSPHERE.
Lehigh Univ., Bethlehem, PA. Dept. of Civil Engineering.
H. Y. Fang.
IN: Hazardous and Industrial Wastes: Proceedings of the 22nd Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 702-717. 7 fig, 1 tab, 19 ref.

Descriptors: *Hazardous waste disposal, *Path of pollutants, *Radioactivity, *Radon, *Soil gases, *Soil water, Air pollution sources, Environmental effects, Interstitial water, Land development, Noble gases, Temperature effects.

Recent findings indicate that radon is not a totally inert element as previously thought. It can be influenced by local environments such as temperature, pH value, ion exchange, and redox reaction to some degree. Radon gas also interacts with soil, water, air and others; unfortunately, the interface mechanisms between radon and the environment are not yet clearly understood. A new approach

was examined that assumed radon gas interaction with the environment through dust in the air and suspensions in the water and soil-water system. It was found that radon/dust-suspension can be treated as a composite particle and its behavior can be evaluated by particle energy field theory which is based on a physico-chemical-biological concept. Hazardous waste disposal can cause changing soil-water structure. Also, an increase in the bacterial activity, which will change pore fluid characteristics between soil layers, will accelerate the radon emanation and mobilization capacity which leads to radon escaping from the ground into the atmosphere. The combination of construction and hazardous waste disposal activities can destroy the dynamic equilibrium of the ecosystem and trigger the radon movement into the atmosphere. It is suggested that less disturbance of the natural ecosystem, the less radon content in the atmosphere. (See also W91-07662) (Mertz-PTT)
W91-07709

WATER EROSION AND WATER QUALITY.
Agricultural Research Service, Pullman, WA.
For primary bibliographic entry see Field 2J.
W91-07760

HANDBOOK OF CHEMICAL PROPERTY ESTIMATION METHODS: ENVIRONMENTAL BEHAVIOR OF ORGANIC COMPOUNDS.
W. J. Lyman, W. F. Reehl, and D. H. Rosenblatt.
American Chemical Society, Washington, DC. 1990. 530p.

Descriptors: *Chemical properties, *Fate of pollutants, *Handbooks, *Organic compounds, *Physicochemical properties, Biodegradation, Biological magnification, Boiling point, Density, Diffusion coefficient, Mass transfer, Refractivity, Solubility, Surface tension, Thermal conductivity, Vaporization, Viscosity.

This handbook contains selected estimation methods for physicochemical properties of organic chemicals. Specific instructions are given for the use of each estimation method. The properties covered include conventional properties of pure materials (density, boiling, point, refractive index), properties that describe how a chemical behaves or interacts with a second substance (solubility in water, diffusion coefficient in air, interfacial tension with water), and the fate of trace concentrations in specific environmental situations (rate of hydrolysis in water, atmospheric residence time, and volatilization from soil). Chapters related to environmental fate propose models that require input information on the environmental compartment of concern as well as chemical-specific properties. The properties of rate of aqueous photolysis and rate of biodegradation are included even though the current state of the art does not permit quantitative estimation. Two chapters stress the importance of photolysis and biodegradation in environmental fate and should allow a qualitative determination of the susceptibility of an organic chemical to these forms of degradation. Additional properties that may be estimated include: critical temperature, critical pressure, Henry's law constant, mass transfer coefficients, molar refractivity, molar volume at the boiling point, and parachor. (See W91-07768 thru W91-07793) (Geiger-PTT)
W91-07767

OCTANOL/WATER PARTITION COEFFICIENT.
Little (Arthur D.), Inc., Cambridge, MA.
For primary bibliographic entry see Field 2K.
W91-07768

SOLUBILITY IN WATER.
Little (Arthur D.), Inc., Cambridge, MA.
For primary bibliographic entry see Field 2K.
W91-07769

SOLUBILITY IN VARIOUS SOLVENTS.
Little (Arthur D.), Inc., Cambridge, MA.
For primary bibliographic entry see Field 2K.
W91-07770

ADSORPTION COEFFICIENT FOR SOILS AND SEDIMENTS.
Little (Arthur D.), Inc., Cambridge, MA.
W. J. Lyman.
IN: Handbook of Chemical Property Estimation Methods: Environmental Behavior of Organic Compounds. American Chemical Society, Washington, DC. 1990. p 4.1-4.33. 3 fig, 11 tab, 44 ref.

Descriptors: *Adsorption, *Adsorption kinetics, *Organic compounds, *Path of pollutants, *Regression analysis, *Sediments, *Soil types, Aromatic compounds, Fate of pollutants, Mathematical models, Organic carbon, Pesticides, Physicochemical properties, Test procedures.

The extent to which an organic chemical partitions itself between the solid and solution phases of a water-saturated or unsaturated soil, or runoff water and sediment, is determined by several physical and chemical properties of both the chemical and the soil (or sediment). In most cases it is possible to express the tendency of a chemical to be adsorbed in terms of a parameter, Koc, which is largely independent of the properties of the soil or sediment. Koc may be thought of as the ratio of the amount of chemical adsorbed per unit weight of organic carbon in the soil or sediment to the concentration of the chemical in solution at equilibrium. All of the available methods for estimating Koc involve empirical relationships with some other property of the chemical, namely water solubility (S), octanol-water partition coefficient (Kow), bioconcentration factor for aquatic life (BCF), or parachor (P). The relationships are regression equations obtained from various data sets and are usually expressed in log-log form. Although Kow has been used most frequently, about a dozen equations have been reported. Each was derived from a different data set representing different chemicals such as insecticides, herbicides, fungicides, or compounds of related structure. By basing the adsorption coefficients on soil (or sediment) organic carbon (Koc) rather than on total mass (K), much of the variation in sorption coefficients between different soils and sediments can be eliminated. The remaining variation may be due to other characteristics of soils such as clay content and surface area, cation exchange capacity, pH, the nature of the organic matter present, and/or variations in the test methods. Other factors that affect the measured value of Koc or are operative under actual environmental conditions are temperature, pH of soil and water, particle size distribution and surface area of solids, salinity of water, concentration of dissolved organic matter, suspended particulate matter in surface water, non-equilibrium adsorption mechanisms or failure to reach equilibrium conditions, solids to solution ratio, loss of chemical due to volatilization, chemical or biological degradation or adsorption on flask walls, and nonlinear isotherms. (See also W91-07767) (Geiger-PTT)
W91-07771

BIOCONCENTRATION FACTOR IN AQUATIC ORGANISMS.
S. E. Bysshe.
IN: Handbook of Chemical Property Estimation Methods: Environmental Behavior of Organic Compounds. American Chemical Society, Washington, DC. 1990. p 5.1-5.30. 1 fig, 12 tab, 41 ref.

Descriptors: *Aquatic life, *Bioaccumulation, *Biological magnification, *Path of pollutants, Adsorption, Biological properties, Mathematical studies, Octanol/water partition coefficient, Regression analysis, Solubility.

The bioconcentration factor (BCF) indicates the degree to which a chemical residue may accumulate in aquatic organisms (usually fish) coincident with ambient concentrations of the chemical in water. Regression equations of BCF values exist for a variety of organic compounds based on flow-through laboratory tests using various fish and invertebrates. If the BCF of a compounds has not been measured or is not readily available, it may be calculated from existing physical and chemical data, namely water solubility (S), octanol-water partition coefficient (Koc), or soil adsorption coefficient (Koc). Sources of discrepancies between BCF estimates and laboratory data include the variability inherent in biological responses and factors responsible for measurement inaccuracy. Errors in measuring the physical/chemical properties correlated with BCF are also responsible for some of the discrepancies observed. Test conditions such as pH and temperature have a marked effect on measurements of S and Koc for some chemical species. Solubility is difficult to measure for very insoluble compounds. Errors in measurement of BCF itself under laboratory conditions are also a source of discrepancies in the measurement of BCF under field conditions. Model ecosystems have been used in place of flow-through systems for estimating BCF, however, these systems are subject to the same potential sources of error as flow-through systems. (See also W91-07767) (Geiger-PTT)
W91-07772

ACID DISSOCIATION CONSTANT.
For primary bibliographic entry see Field 2K.
W91-07773

RATE OF HYDROLYSIS.
J. C. Harris.
IN: Handbook of Chemical Property Estimation Methods: Environmental Behavior of Organic Compounds. American Chemical Society, Washington, DC. 1990. p 7.1-7.48. 3 fig, 11 tab, 34 ref.

Descriptors: *Chemical degradation, *Fate of pollutants, *Hydrolysis, *Organic acids, *Organic compounds, Catalysis, Correlation analysis, Hydrogen ion concentration, Kinetics, Mathematical studies, Temperature effects.

Hydrolysis is a chemical transformation process in which an organic molecule, RX, reacts with water, forming a new carbon-oxygen bond and cleaving a carbon-X bond in the original molecule. Hydrolysis is likely to be the most important reaction of organic compounds with water in aqueous environments and is a significant environmental fate process for many organic chemicals. Hydrolysis is a family of reactions involving compound types as diverse as alkyl halides, carboxylic acid esters, organophosphonates, carbamates, epoxides, and nitriles. When an organic compound undergoes hydrolysis, a nucleophile (water or hydroxide ion) attacks an electrophile (carbon atom, phosphorus atom, etc.) and displaces a leaving group (chloride, phenoxide, etc.). The hydrolysis of organic chemicals in water is first-order in the concentration of the organic species; the rate of disappearance of RX is directly proportional to the concentration of the compound. Experimental measurement of the rate of hydrolysis should involve the determination of the form of the rate law, the magnitude of the rate constants, the products of reaction, and temperature dependence (energy of activation). The rate of hydrolysis of organic chemicals increases with temperature. The quantitative relationship between the rate constant and temperature is frequently expressed by the Arrhenius equation. Hydrolysis reactions, which frequently involve ionic species as reactants, intermediates, and/or products, are affected by changes in the solvating power of the reaction medium. Estimation methods for hydrolysis include the application of linear free energy relationships, estimation of rate constant for specific acid-catalyzed hydrolysis by the Hammett, or Taft correlations, estimation of the rate constant for neutral hydrolysis by the Hammett correlation, and estimation of the rate constant for specific base-catalyzed hydrolysis by the Hammett or Taft correlations or correlation with the negative log of the acid dissociation constant of a leaving group. (See also W91-07767) (Geiger-PTT)
W91-07774

RATE OF AQUEOUS PHOTOLYSIS.
J. C. Harris.
IN: Handbook of Chemical Property Estimation Methods: Environmental Behavior of Organic Compounds. American Chemical Society, Washington, DC. 1990. p 8.1-8.43. 7 fig, 12 tab, 40 ref.

Descriptors: *Degradation, *Fate of pollutants, *Organic compounds, *Photolysis, Adsorption, Mathematical models, Photochemistry.

Photochemical processes may be important in determining the fate of organic pollutants in aqueous environments. Both direct photolysis, in which the pollutant itself absorbs solar radiation, and sensitized photolysis, in which energy is transferred from some other species in the aquatic solution, may occur. The rates of these processes in a natural water system depend both on the properties of the aquatic environment (intensity and spectrum of solar radiation, presence or absence of sensitizers, quenchers, etc.) and on the properties of the organic chemical (extent of absorption of light and inherent tendency to undergo photochemical reaction. Existing models for predicting photochemical reactivity in the environment are essentially models for calculating the net rate at which an aqueous solution containing the organic chemical absorbs light. The basic approach is to evaluate the degree of overlap between the ultraviolet/visible absorption spectrum of the organic molecule and the solar radiation to which it is exposed. An organic molecule can undergo photochemical transformations if light energy is absorbed by the molecule to produce an electronically excited state of the molecule, and chemical transformations of the excited state are competitive with deactivation processes. A qualitative model for calculating the rate of absorption of light in aquatic environments evaluates the degree of overlap between the UV/visible absorption spectrum of an organic compound and the incident solar energy in an aquatic environment. The molar absorptivities at the specified wavelengths are obtained experimentally by determination of the UV/visible spectrum of the compound. Primary photochemical processes in organic molecules include fragmentation into free radicals or neutral molecules, rearrangement and isomerization reactions, photoreduction by hydrogen atom abstraction from other molecules, dimerization and related addition reactions, photoionization, and electron transfer reactions. Photochemical reaction processes that are typical of various organic compound categories are summarized. Both the rate and the products of photochemical degradation may be influenced by such factors in the environment as suspended sediment, surfactants, sensitizers, and quenchers. (See also W91-07767) (Geiger-PTT)
W91-07775

RATE OF BIODEGRADATION.
K. M. Scow.
IN: Handbook of Chemical Property Estimation Methods: Environmental Behavior of Organic Compounds. American Chemical Society, Washington, DC. 1990. p 9.1-9.85. 15 fig, 23 tab, 177 ref.

Descriptors: *Biodegradation, *Fate of pollutants, *Microbial degradation, *Organic compounds, *Wastewater treatment, Activated sludge, Anaerobic digestion, Hydrolysis, Mineralization, Oxidation, Soil bacteria, Soil water potential.

Biodegradation is one of the most important environmental processes that cause the breakdown of organic compounds. It is a significant loss mechanism in soil and aquatic systems and plays an essential role in wastewater treatment. The eventual mineralization of organic compounds can be attributed almost entirely to biodegradation. Almost all of the reactions involved in biodegradation can be classified as oxidative, reductive, hydrolytic or conjugative. Microorganisms are the most significant group of organisms involved in biodegradation. Soil, water and wastewater treatment systems provide the most important microbial habitats for the biodegradation of pollutants. In all three habitats both aerobic and anaerobic conditions exist. The microorganisms involved in anaerobic digestion are primarily bacteria, both facultative and obligate anaerobes. The acid-forming bacteria have higher rates of reproduction and tolerate a pH as low as 5.0. Methane-forming bacteria are inhibited at a pH below 6.5 and are generally more sensitive to temperature and substrate concentration. Variables in biodegradation may be substrate-, organism-, or environment-related. To measure biodegradation, a microbial population is collected from an environmental source and isolated through enrichment cultures. The population is incubated with the substrate in some medium, with or without additional nutrient or energy supply, and the rate of disappearance of the substrate is monitored through indirect or direct analytical techniques. Standard tests for measuring biodegradation in aquatic environments include: shake flask, river die-away, and BOD respirometer. Standard tests for measuring biodegradation in soil include: soil perfusion, soil incubation, and soil suspended in aqueous solution. Standard tests for measuring biodegradation in anaerobic environments include: anaerobic digestion and closed river die-away. Standard tests for measuring biodegradation in activated sludge include: semi-continuous activated sludge, trickling filter, and recirculating filter. The power rate law and the hyperbolic rate law have been proposed to describe the rate of biodegradation. Biodegradation rate constants for various organic compounds reported in the literature are tabulated. Biodegradability has been correlated with molecular characteristics and other chemical properties such as solubility, BOD/COD, and hydrolysis. (See also W91-07767) (Geiger-PTT)
W91-07776

ATMOSPHERIC RESIDENCE TIME.
Little (Arthur D.), Inc., Cambridge, MA.
W. J. Lyman.
IN: Handbook of Chemical Property Estimation Methods: Environmental Behavior of Organic Compounds. American Chemical Society, Washington, DC. 1990. p 10.1-10.33. 1 fig, 8 tab, 37 ref.

Descriptors: *Acid rain, *Air pollution, *Atmospheric residence time, *Model studies, *Path of pollutants, *Residence time, Mathematical models, Organic compounds, Precipitation scavenging, Statistical analysis.

The residence time of a chemical in a specified atmospheric compartment (total atmosphere, troposphere, stratosphere, etc.) is well defined only under steady-state conditions, i.e, when the total mass and the statistical distribution in the compartment do not vary with time. In such cases the residence time may be simply defined as the ratio of the total mass in the compartment to the total emission rate or removal rate. Five methods for estimating atmospheric residence time are: steady-state models, one compartment nonsteady-state models, two compartment nonsteady-state models, use of chemical reactivity data, and correlation with mean standard deviation (Junge's correlation). The use of a steady-state model for estimating tropospheric residence time is limited to those cases where the total growth rate of the chemical in the troposphere (caused by emissions from land and oceans plus input, if any, from the stratosphere) may be assumed to equal the total removal rate of the chemical in the same compartment via outflow plus chemical degradation. Nonsteady-state methods are appropriate for anthropogenic pollutants for which recent emissions have been increasing exponentially. The one-compartment model considers the whole troposphere as the compartment of interest, making no distinction between the northern and southern hemispheres. The two-compartment model is appropriate for anthropogenic pollutants for which tropospheric burdens and removal rates in the northern and southern hemispheres are expected to differ. The residence time of a chemical in the atmosphere may be estimated if the rate constants for one or more destruction or removal processes are known. The reactions most frequently considered are those with hydroxyl radicals and with ozone. The only data requirements for Junge's correlation are an adequate number of measurements of the atmospheric concentration (over appropriate space and time scales) so that an accurate average and standard deviation can be obtained. Using such data, mostly for trace inorganic gases, a correlation was shown to exist between the mean standard deviation and the tropospheric residence time. (See also W91-07767) (Geiger-PTT)
W91-07777

ACTIVITY COEFFICIENT.
For primary bibliographic entry see Field 2K.
W91-07778

BOILING POINT.
For primary bibliographic entry see Field 2K.
W91-07779

HEAT OF VAPORIZATION.
For primary bibliographic entry see Field 2K.
W91-07780

VAPOR PRESSURE.
C. F. Grain.
IN: Handbook of Chemical Property Estimation Methods: Environmental Behavior of Organic Compounds. American Chemical Society, Washington, DC. 1990. p 14.1-14.20. 5 tab, 17 ref.

Descriptors: *Organic compounds, *Path of pollutants, *Physicochemical properties, *Vapor pressure, Boiling point, Evaporation, Mathematical models, Prediction, Temperature, Vaporization.

Reliable methods for estimating the vapor pressure of organic materials are of increasing importance as a tool in predicting the behavior and fate of chemicals that are introduced into the environment. Equations for estimating vapor pressure require information on at least three of the following properties: the critical temperature, the critical pressure, the heat of vaporization, and/or the vapor pressure at some reference temperature. The equations that relate vapor pressure to temperature are commonly derived by integration of the Clausius-Clapeyron equation. Two methods of estimating vapor pressure are recommended that require a minimum of experimental data and are applicable to almost any organic material over a wide pressure range. Their accuracy is quite good over the temperature range of interest to environmental scientists. The first method is based on Antoine's equation and is generally applicable over the pressure range from 760 mm to .001 mm. The second method is based on the modified Watson correlation and is applicable over the pressure range from 760 mm to at least .0000001 mm. An estimation of vapor pressure from boiling points at reduced pressure can be made using the ideal gas laws and the Kistiakovskii equation. (See also W91-07767) (Geiger-PTT)
W91-07781

VOLATILIZATION FROM WATER.
R. G. Thomas.
IN: Handbook of Chemical Property Estimation Methods: Environmental Behavior of Organic Compounds. American Chemical Society, Washington, DC. 1990. p 15.1-15.34. 5 fig, 4 tab, 23 ref.

Descriptors: *Mass transfer, *Organic compounds, *Path of pollutants, *Vaporization, *Volatility, Air-water interfaces, Mathematical models, Molecular weight, Solubility, Vapor pressure.

The vaporization of organic chemicals from water bodies is an important mass-transfer pathway from water to air. The factors that control volatilization are the solubility, molecular weight, and vapor pressure of the chemical and the nature of the air-water interface through which it must pass. The mathematical modeling of volatilization involves the use of interphase exchange coefficients that depend on these properties which are difficult to measure or estimate in the actual environment. Four basic approaches exist for the estimation of the volatilization rate. The method of Mackay and Wolkoff expresses the flux from a solution in water to the air above in terms of the ratio of contaminant mass in the vapor phase to the total vapor mass of the water plus chemical, expressed as a function of the chemical vapor pressure. The method of Liss and Slater analyzes volatilization on the basis of a two-layer film. Transfer through these films is by straightforward molecular diffusion. The molecules are assumed to diffuse through the layers at a rate dependent on the phase exchange coefficients found in the equations rather than to vaporize directly from solution along with the water vapor. The method of Chiou and Freed

is based on gas dynamic and thermodynamic considerations involving the mean free path of molecules and the vapor pressures of the chemical. A Langmuir-type equation is used to describe observed rates of volatilization from both single-component and multicomponent systems. The method of Smith et al is based on reaeration studies that demonstrate that inert gases could be used as tracers for oxygen reaeration measurement. The volatilization rate can be related to the rate of oxygen reaeration for certain compounds, a value which is known for natural systems such as rivers and lakes. Difficulties in performing in-situ volatilization experiments makes it impossible to quantify the error in the calculated values of the volatilization rate constants. (See also W91-07767) (Geiger-PTT)
W91-07782

VOLATILIZATION FROM SOIL.
R. G. Thomas.
IN: Handbook of Chemical Property Estimation Methods: Environmental Behavior of Organic Compounds. American Chemical Society, Washington, DC. 1990. p 16.1-16.50. 6 fig, 8 tab, 28 ref.

Descriptors: *Air-earth interfaces, *Evaporation, *Organic compounds, *Path of pollutants, *Soil contamination, *Volatility, Adsorption, Diffusion, Mathematical models, Organic solvents, Soil water, Vapor pressure.

Volatilization is the process by which a compound evaporates in the vapor phase to the atmosphere from another environmental compartment. Volatilization may be an important mechanism for the loss of chemicals from the soil and transfer to the air. The rate at which a chemical volatilizes from soil is affected by many factors, such as soil properties, chemical properties, and environmental conditions. Adsorption reduces the chemical activity below that of the pure compound and affects the vapor density and the volatilization rate. Soil water content also affects volatilization losses by competing for adsorption sites on the soil. An increase in temperature normally increases the equilibrium vapor density, which in turn increases the volatilization rate. Air flow over the soil surface can influence the rate of volatilization by increasing evaporation or decreasing soil water content and decreasing volatilization. Chemicals in the soil can volatilize through the action of the wick effect or wick evaporation. The chemical is transported from the soil body to the surface by capillary action. The Hartley method presents two fairly simple equations to estimate the volatilization of chemicals from soil based on analysis of the heat balance between the evaporating chemical (or water) and air. The Hamaker method of estimating volatilization of a chemical from the soil assumes the impregnated soil layer is semi-infinite; i.e., the total depth is large in comparison with the depth to which the soil is significantly depleted of the chemical by diffusion and volatilization. A second method presented by Hamaker is based on total water loss, i.e., the loss due to vapor diffusion as well as the mass transfer of soil solution. The Mayer, Letey, and Farmer method applies the diffusion laws to the mathematical description of the movement of chemicals in soils under a concentration gradient. Five different solutions of the model are each applicable to a different set of boundary conditions. The Jury, Grover, Spencer, and Farmer method predicts the flux of a chemical in both the presence and absence of the wick effect. The Dow Chemical Company studied nine chemicals and derived a correlation that could predict the volatilization of these chemicals for a soil surface under laboratory conditions. Selection criteria for the best method and examples of their use are given along with an evaluation of the error function which must be used in the solution of some of the diffusion equations. (See also W91-07767) (Geiger-PTT)
W91-07783

DIFFUSION COEFFICIENTS IN AIR AND WATER.
W. A. Tucker, and L. H. Nelken.
IN: Handbook of Chemical Property Estimation Methods: Environmental Behavior of Organic Compounds. American Chemical Society, Washington, DC. 1990. p 17.1-17.25. 7 tab, 28 ref.

Descriptors: *Air-water interfaces, *Diffusion, *Diffusion coefficient, *Fate of pollutants, *Organic compounds, *Path of pollutants, Groundwater pollution, Interstitial water, Mass transfer, Mathematical models, Molecular structure.

Molecular diffusion is the net transport of a molecule in a liquid or gas medium and is a result of intermolecular collisions rather than turbulence or bulk transport. The rate of diffusion is a function of the properties of the compound being transported and the properties of the medium through which it moves. Molecular diffusion is a significant, or even controlling factor in determining chemical fluxes in air-water interfaces, the interstitial waters of sediments, and groundwater (saturated or unsaturated soils). The method of Fuller, Schettler and Giddings (FSG method) is most accurate for estimating gaseous diffusion coefficients of non-polar gases in air at low to moderate temperatures. The accuracy of the FSG method is poorest with the polar acids and glycols and best with the aliphatics and aromatics. The Wilke and Lee (WL) method for estimating gaseous diffusion coefficients is applicable to a wider range of compounds and temperatures than the FSG method. The absolute average error using the WL method for about 150 compounds was 4.3%; all classes of compounds had average errors of less than 8%, except for acids. The WL method is significantly more accurate than the FSG method for nitriles, aromatic esters, and glycols. Four methods are recommended for estimating the liquid diffusion coefficient in water. The Wilke-Change method incorporates a solution association constant which is a function of the solution polarity. Wilke and Change assigned a value of 2.6 for aqueous solutions, fitting experimental data published prior to 1950. They calculated an average error of 10% for an unspecified number of compounds. Using a data set of more recently measured values, Hayduk and Laudie found that an association parameter of 2.26 reduced the average error 5.8%. The method of Scheibel requires the molal volumes of both the solute and solvent. Scheibel theorized that the mechanism of diffusion is a function of the relative sizes of the molecules comprising a liquid binary system. (See also W91-07767) (Geiger-PTT)
W91-07784

SURFACE TENSION.
C. F. Grain.
IN: Handbook of Chemical Property Estimation Methods: Environmental Behavior of Organic Compounds. American Chemical Society, Washington, DC. 1990. p 20.1-20.16. 6 tab, 11 ref.

Descriptors: *Organic compounds, *Path of pollutants, *Physical properties, *Physicochemical properties, *Surface tension, Density, Estimating, Mathematical models, Molecular structure, Temperature.

The surface tension is defined as the force per unit length (usually dynes/cm) in the plane of the surface. Surface tension affects the extent of spreading when a liquid chemical is spilled on land or water. It is also important with respect to the emulsification of liquids that are mixed with water and in the their adsorption on solid surfaces. The MacLeod-Sugden method provides a simple and surprisingly accurate method for estimating surface tension if measured liquid densities are available as a function of temperature. The method offers an empirical relationship between surface tension, liquid density, and parachor. A variation of this method (Grain's method) allows calculation of surface tension when a measured value of liquid density is unavailable by using a ratio of temperature to the normal boiling point. The Grain method is not recommended for calculating specific gravity if the temperature is above the normal boiling point of the compound. (See also W91-07767) (Geiger-PTT)
W91-07787

HEAT CAPACITY.
For primary bibliographic entry see Field 2K.
W91-07790

THERMAL CONDUCTIVITY.
For primary bibliographic entry see Field 2K.
W91-07791

WATER QUALITY OF INTERSTATE STREAMS IN THE SUSQUEHANNA RIVER BASIN MONITORING REPORT NO. 3, WATER YEAR 1989 (OCTOBER 1988-SEPTEMBER 1989).
Susquehanna River Basin Commission, Harrisburg, PA.
C. P. McMorran, and S. W. Bollinger.
Publication No. 131, April 1990. Susquehanna River Basin Commission, Harrisburg, Pennsylvania. 114p, 6 fig, 40 tab, 4 ref, 2 append.

Descriptors: *Interstate rivers, *Monitoring, *Susquehanna River Basin, *Water quality, Aluminum, Benthic fauna, Bioassay, Cowanesque Lake, Cowanesque River, Deer Creek, Macroinvertebrates, Maryland, Octoraro Creek, Scott Creek, Seasonal variation, Tioga River, Troups Creek, Trowbridge Creek.

Water samples were collected from twelve stations on interstate streams in November 1988, and February, May and August 1989. Water samples were collected from 23 stations on other interstate streams. Benthic macroinvertebrates were sampled from each station in July and August 1989. The data collected is used: (1) to assess compliance with water quality standards; (2) to assess impacts on water quality; (3) to characterize ambient and seasonal stream quality; and (4) for future trend assessment. Scott Creek is the only interstate stream having poor water quality. Untreated sewage discharges from Cardiff, Maryland impairs water quality and biological conditions. The Cowanesque River exhibits biological impacts due to Cowanesque Lake, but impacts on water quality were minor. The Chemung River showed slight to moderate impairment of macroinvertebrates and water quality due to wastewater discharges from Elmira. Octoraro Creek and Tioga River showed moderate macroinvertebrate impairment coincident with elevated concentrations of some chemical parameters. Elevated chemical concentrations were observed in the Susquehanna River at Sayre and Cayuta Creek; however, no macroinvertebrate impairment was observed. Falling Branch Deer Creek, Big Branch Deer Creek, Troups Creek and Trowbridge Creek showed varying degrees of macroinvertebrate impairment, but no specific causes were indicated by water quality data. Most interstate streams have good water quality. Only 39 out of 1,460 observations exceeded water quality standards. Aluminum most commonly exceeded standards. (Author's abstract)
W91-07818

EFFECTS OF AGRICULTURE ON QUALITY OF WATER IN SURFICIAL SAND-PLAIN AQUIFERS IN DOUGLAS, KANDIYOHI, POPE, AND STEARNS COUNTIES, MINNESOTA.
Geological Survey, St. Paul, MN. Water Resources Div.
For primary bibliographic entry see Field 4C.
W91-07821

NITROGEN DYNAMICS IN THE TIDAL FRESHWATER POTOMAC RIVER, MARYLAND AND VIRGINIA, WATER YEARS 1979-81: A WATER-QUALITY STUDY OF THE TIDAL POTOMAC RIVER AND ESTUARY.
For primary bibliographic entry see Field 2L.
W91-07822

CRITICAL EVALUATION OF THE AVAILABLE MEASUREMENTS FOR THE STABLE ISOTOPES OF BORON.
Arizona Univ., Tucson. Dept. of Hydrology and Water Resources.
For primary bibliographic entry see Field 2K.
W91-07827

BA AND SR DISTRIBUTION AT THE WATER-TABLE: IMPLICATIONS FOR MONITORING GROUND-WATER AT NUCLEAR WASTE REPOSITORY SITES.
Weizmann Inst. of Science, Rehovoth (Israel). Dept. of Isotope Research.
For primary bibliographic entry see Field 2K.
W91-07828

PCDDS IN THE SEDIMENTS ACCUMULATED ABOUT 8120 YEARS AGO FROM JAPANESE COASTAL AREAS.
Ehime Univ., Matsuyama (Japan). Dept. of Environment Conservation.
For primary bibliographic entry see Field 5A.
W91-07837

BIOTRANSFORMATION AND TISSUE DISTRIBUTION OF 1,2,3,7-TETRACHLORODIBENZO-P-DIOXIN, 1,2,3,7-PENTACHLORODIBENZO-P-DIOXIN, AND 2,3,4,7,8-PENTACHLORODIBENZOFURAN IN RAINBOW TROUT.
Utrecht Rijksuniversiteit (Netherlands). Research Group for Aquatic Toxicology.
D. T. H. M. Sijm, A. L. Yarechewski, D. C. G. Muir, G. R. Barrie Webster, and W. Seinen.
Chemosphere CMSHAF, Vol. 21, No. 7, p 845-866, 1990. 4 fig, 8 tab, 37 ref.

Descriptors: *Bioaccumulation, *Biotransformation, *Dioxins, *Fate of pollutants, *Inhibition, *Path of pollutants, *Tissue analysis, *Trout, Absorption, Carbon radioisotopes, Depuration, Elimination, Furans, Gills, Isotope studies, Liver, Muscle, Piperonylbutoxide, Polychlorinated dibenzo-p-dioxins, Polychlorinated dibenzofurans, Toxicology.

Two polychlorinated dibenzo-p-dioxins were eliminated more slowly in rainbow trout which were treated with an inhibitor of biotransformation. Fish were given a single oral dose of either 14-C labeled 1,2,3,7-tetrachlorodibenzo-p-dioxin (T4CDD), 1,2,3,4,7-pentachlorodibenzo-p-dioxin (P5CDD), or 2,3,4,7,8-pentachlorodibenzofuran (P5CDF). Half of the fish were treated daily with piperonylbutoxide (PBO), a well known inhibitor of monooxygenase activity. The amounts of radioactivity were determined for various organs 2, 7, 14, and 21 days following administration. T4CDD and P5CDD were both eliminated more slowly in the PBO treated fish than in the fish which did not receive PBO. P5CDF did not show any statistically different elimination rates in PBO treated and untreated fish. For all compounds, the highest concentrations were found in the liver and intestines. The highest absolute amount of each compound was found in muscle tissue. The slower elimination rates and the higher body burden of T4CDD and P5CDD in PBO treated trout indicated that biotransformation is very important for their elimination kinetics. Biotransformation may thus be responsible for the more rapid elimination and lower body burden of these compounds under normal conditions. (Author's abstract)
W91-07838

CONTRIBUTION OF SOIL CONSTITUENTS IN ADSORPTION COEFFICIENT OF AROMATIC COMPOUNDS, HALOGENATED ALICYCLIC AND AROMATIC COMPOUNDS TO SOIL.
Keio Univ., Yokohama (Japan). Faculty of Science and Technology.
H. Kishi, N. Kogure, and Y. Hashimoto.
Chemosphere CMSHAF, Vol. 21, No. 7, p 867-876, 1990. 1 fig, 5 tab, 8 ref.

Descriptors: *Adsorption, *Aromatic compounds, *Benzenes, *Clays, *Loam, *Organic carbon, *Path of pollutants, *Soil analysis, *Soil contamination, *Soil properties, *Soil water, Adsorption kinetics, Hydrophobic compounds, Japan, Lindane, Naphthalenes, Soil types.

The movement of chemicals in the biosphere is largely dependent on physical and chemical interactions with other components and environmental elements such as suspended soils, sediment, and biota. In particular, the organic carbon content of soils determines the adsorptivity of hydrophobic organic compounds and affects the value of the adsorption coefficient (kd). Therefore, the adsorption coefficient is usually normalized to the organic carbon content in the soil, and is expressed as koc. The current study measured adsorption coefficients for six kinds of alicyclic and aromatic compounds (lindane, naphthalene, dipheny), 1,2,3,-trichlorobenzene, and 1,2,3,4-tetrachlorobenzene) and five kinds of soil having different organic carbon contents and clay mineralogy. Findings illustrated that the normalized adsorption coefficient values were different for each of the soils tested. Adsorptivity was defined as a slope, Koc, of the linear regression of organic carbon content vs. adsorption coefficient in the five kinds of soil. A ratio of koc against Koc, calculated for each chemical was found to be constant for the same soil type with different chemicals. This ratio was used as a compensation factor for changes of koc in different soils. The compensated koc in each soil was nearly equal to Koc. The compensated koc is useful for comparisons of adsorptivity of hydrophobic organic compounds in soil. (Korn-PTT)
W91-07839

LEVELS AND SOURCES OF PCDDS AND PCDFS IN URBAN BRITISH SOILS.
University of East Anglia, Norwich (England). School of Chemical Sciences.
C. S. Creaser, A. R. Fernandes, S. J. Harrad, and E. A. Cox.
Chemosphere CMSHAF, Vol. 21, No. 8, p 931-938, 1990. 2 fig, 3 tab, 12 ref. U.K. Department of the Environment, H. M. Inspectorate of Pollution Contract No. 7/10/100.

Descriptors: *Dioxins, *England, *Furans, *Path of pollutants, *Soil analysis, *Soil contamination, *Urban areas, *Water pollution sources, Incineration, Mass transport, Municipal wastes, Organic compounds.

An investigation was undertaken in which soil samples from five British cities were analyzed for polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs). Soil and source matrix samples were analyzed using a modified procedure which showed improved sample clean-up for some complex soils and better isomer specificity. The observed PCDD and PCDF isomer distributions for soils were correlated with those for samples of known origin using principal component analysis. Mean levels of PCDDs and PCDFs in soils from British cities were significantly higher than those from rural and semi-rural locations. The concentrations of the lower PCDD and PCDF congener groups showed the greatest increase; the higher tetra:octa and penta:octa PCDD and PCDF congener ratios appeared to be characteristic of urban soils. Principal component analysis using congener group data and selected individual isomers for urban soils and known source samples, indicated that combustion processes, such as coal burning and municipal waste incinerators were the principal sources of PCDDs and PCDFs in these soils, while a small number of samples suggested major contributions from other sources. (Korn-PTT)
W91-07840

BIOACCUMULATION OF ZINC AND CADMIUM IN FRESHWATER ALGA, CHLORELLA VULGARIS. PART I. TOXICITY AND ACCUMULATION.
Kagoshima Univ. (Japan). Dept. of Applied Chemistry.
S. Maeda, M. Mizoguchi, A. Ohki, and T. Takeshita.
Chemosphere CMSHAF, Vol. 21, No. 8, p 953-963, 1990. 10 fig, 1 tab, 5 ref.

Descriptors: *Bioaccumulation, *Cadmium, *Chlorella, *Path of pollutants, *Toxicity, *Zinc, Algae, Bioassay, Biological studies, Cadmium radioisotopes, Growth, Heavy metals, Inhibitors, Japan, Zinc radioisotopes.

The essential trace metallic element, zinc, and the non-essential metal, cadmium, were investigated for toxicity and accumulation in a freshwater alga, Chlorella vulgaris. Radioactive Zn and Cd were used for the bioaccumulation experiments. A lag phase in the growth curve appeared when the concentration of Zn in the medium exceeded 80 mg/L. However, growth recovered in a few days, indicating that zinc resistance was induced in the cell during the lag time. Cadmium, however, had a significant impact on algal growth as evidenced by the death of algal cells when Cd concentrations exceeded 25 mg/L. This implied that Cd was more toxic to C. vulgaris than zinc. Additional experimental results revealed that a total of 350,000 mg/kg of zinc was accumulated by the cells from the aqueous medium containing 100 mg/L of the metal. When the aqueous medium contained 10 mg/L of Cd, the cells accumulated 18,000 mg/kg of the metal. Accumulation of zinc by the cells was affected both by NaN3 (a photosynthesis inhibitor) and dinitrophenol (a respiratory inhibitor). The experiments revealed that zinc was predominantly accumulated by biological processes while cadmium was predominantly accumulated by physicochemical process. (See also W91-07842) (Korn-PTT)
W91-07841

BIOACCUMULATION OF ZINC AND CADMIUM IN FRESHWATER ALGA, CHLORELLA VULGARIS, PART II. ASSOCIATION MODE OF THE METALS AND CELL TISSUE.
Kagoshima Univ. (Japan). Dept. of Applied Chemistry.
S. Maeda, M. Mizoguchi, A. Ohki, J. Inanaga, and T. Takeshita.
Chemosphere CMSHAF, Vol. 21, No. 8, p 965-973, 1990. 5 fig, 3 tab, 3 ref.

Descriptors: *Adsorption, *Bioaccumulation, *Cadmium, *Chlorella, *Path of pollutants, *Pollutant identification, *Tissue analysis, *Zinc, Algae, Biological studies, Cadmium radioisotopes, Desorption, Gel filtration, Isotope studies, Japan, Metallothioneins, Proteins, Zinc radioisotopes.

The association mode of zinc and cadmium in Chlorella vulgaris was investigated by the use of radioactive 65-Zn and 115-Cd. Whereas only 3.5% of the Zn bioaccumulated by C. vulgaris was desorbed with 0.1 mM EDTA when the bioaccumulation level was at 350,000 microgram Zn/g dry weight, 81% of the Zn accumulated was desorbed with 0.1 mM EDTA when the bioaccumulation rate was at 900 microgram/g dry weight. Almost all (i.e., 99.7%) of the zinc accumulated was associated with the residue of solvent extraction with CHC3/CH3OH/H2O (8:4:3). Gel filtration data showed that zinc was associated with proteins of molecular weight of 6000, and cadmium was associated with proteins of molecular weights of 6000 and 30000. Cysteine content in the proteins of cadmium-binding tissue was found to be approximately ten-fold higher than that of the control cell. These results indicated that metallothionein-like proteins were inductively synthesized in C. vulgaris, when the cell was exposed to cadmium and zinc. (See also W91-07841) (Author's abstract)
W91-07842

BENZENE AND NAPHTHALENE SORPTION ON SOIL CONTAMINATED WITH HIGH MOLECULAR WEIGHT RESIDUAL HYDROCARBONS FROM UNLEADED GASOLINE.
Robert S. Kerr Environmental Research Lab., Ada, OK.
D. C. Bouchard, S. C. Mravik, and G. B. Smith.
Chemosphere CMSHAF, Vol. 21, No. 8, p 975-989, 1990. 6 fig, 5 tab, 17 ref.

Descriptors: *Benzene, *Gasoline, *Hydrocarbons, *Naphthalenes, *Path of pollutants, *Soil contamination, *Sorption, Adsorption, Groundwater pollution, Organic compounds, Soil analysis, Solute transport, Solvents, Underground storage tanks.

The U.S. Environmental Protection Agency (EPA) estimates that there are 75,000-100,000 underground storage tanks releasing 11 million gallons of gasoline to the subsurface yearly. Uncontrolled releases of gasoline or other petroleum de-

rived fuels, solvents, and lubricants have resulted in widespread soil and groundwater contamination by these water immiscible, or nonaqueous phase liquids (NAPLs). For complex NAPLs, the composition of the NAPL retained in the pore space of geologic materials weathers until the residual NAPL no longer acts as a liquid. Rather, the residual NAPL exists as discrete regions of hydrocarbon in association with the geologic media, or as thin film coatings on the media. Samples of uncontaminated surface soils were treated with unleaded gasoline and tetradecane to determine the effects of residual hydrocarbons on the sorption of neutral organic compounds. The residual hydrocarbons were found to resist separation from the soil solids even when subjected to shaking in batch reactors. In addition, the magnitude of solute sorption was significantly higher for a low organic carbon soil contaminated with residual hydrocarbons than for natural soil organic carbon. At field sites, these experimental results have important implications for estimating contaminant arrival times at monitoring stations and in the in-situ remediation of contaminated soils by pumping and treating the aqueous phase or by soil vacuum extraction. (Korn-PTT)
W91-07843

ORGANIC COMPOUNDS IN PRECIPITATION.
Fraunhofer-Inst. fuer Toxikologie und Aerosolforschung, Hanover (Germany, F.R.).
For primary bibliographic entry see Field 2B.
W91-07844

DETERMINATION AND OCCURRENCE OF AHH-ACTIVE POLYCHLORINATED BIPHENYLS, 2,3,7,8-TETRACHLORO-P-DIOXIN AND 2,3,7,8-TETRACHLORODIBENZOFURAN IN LAKE MICHIGAN SEDIMENT AND BIOTA. THE QUESTION OF THEIR RELATIVE TOXICOLOGICAL SIGNIFICANCE.
Fish and Wildlife Service, Columbia, MO.
L. M. Smith, T. E. Schwartz, K. Feltz, and T. J. Kubiak.
Chemosphere CMSHAF, Vol. 21, No. 9, p 1063-1085, 1990. 6 tab, 68 ref.

Descriptors: *Path of pollutants, *Pollutant identification, *Polychlorinated biphenyls, *Toxicity, Aroclors, Bioaccumulation, Biological magnification, Biota, Birds, Dioxins, Fish eggs, Food chains, Lake sediments.

An analytical procedure has been developed for the determination of the 18 polychlorinated biphenyl (PCB) congeners which are inducers of methylcholanthrene-like mixed function oxidase activity in animals and include the most toxic PCBs. Determinations of the toxic PCB congeners in samples of eggs of predatory fish and piscivorous birds of the Great Lakes and in Aroclor mixtures demonstrate that the apparent toxic potency of PCB residues in these samples is dominated by two congeners, 3,3',4,4',5-pentachlorobiphenyl and 2,3,3',4,4'-pentachlorobiphenyl. Furthermore, the analyses demonstrate that the potential toxicity of PCB residues can increase 5 to 10 fold as they reach upper levels of aquatic food chains and most often exceed the potential toxicity of chlorinated dibenzodioxins and furans in higher animals even in environments highly contaminated by the latter compounds. (Author's abstract)
W91-07845

ADSORPTION AND DESORPTION OF 3,4-DICHLOROANILINE ON SOIL.
Gesellschaft fuer Strahlen- und Umweltforschung m.b.H. Muenchen, Freising-Attaching (Germany, F.R.). Inst. fuer Oekologische Chemie.
R. Beyerle-Pfnur, and J.-P. Lay.
Chemosphere CMSHAF, Vol. 21, No. 9, p 1087-1094, 1990. 2 fig, 3 tab, 16 ref. Commission of the European Community Research Contract No. EV 4V-0110-UK(BA).

Descriptors: *Adsorption, *Chemical reactions, *Desorption, *Dichloroaniline, *Organic compounds, *Path of pollutants, *Soil chemistry, *Soil contamination, Adsorption kinetics, Dyes, Germany, Humic acids, Organic carbon, Surface water.

Recently, 3,4-dichloroaniline (DCA), a hydrolysis product of several urea herbicides and acylanilides, has been detected in various surface waters. Chlorinated anilines are well known to react with soil and are mostly concentrated in organic matter in soil, especially humic acids. The adsorption of DCA on a sediment and two different samples of soil was studied to estimate the possible influence of the organic carbon content on adsorption capacity. Data obtained from kinetic adsorption experiments showed that the reaction occurs in two stages. The first stage may result from a physical interaction between the chemical and the soil, while in the second process a chemical binding between DCA and the organic matter of the soil may occur. Results of the adsorption reactions showed that, under equilibrium conditions, at least 66% of the dissolved chemical was adsorbed on the soil. The adsorption coefficients depend mainly on the concentration of the dissolved DCA and, to a smaller extent, on the type of soil sample. Experimental findings confirm that DCA a polar substance with a reactive amino group which preferentially reacts with organic substances in the soil. Furthermore, reactions between the amino group of DCA and oxygen or carbon of oxygen-containing groups led to strongly bound and stable products. (Korn-PTT)
W91-07846

URBAN RUNOFF POLLUTION BY ORGANOCHLORINES (POLYCHLORINATED BIPHENYLS AND LINDANE) AND HEAVY METALS (LEAD, ZINC, AND CHROMIUM).
Paris-6 Univ. (France). Inst. d'Hydrologie et de Climatologie.
L. Granier, M. Chevreuil, A.-M. Carru, and R. Letolle.
Chemosphere CMSHAF, Vol. 21, No. 9, p 1101-1107, 1990. 2 fig, 6 tab, 21 ref.

Descriptors: *Heavy metals, *Organic compounds, *Path of pollutants, *Storm runoff, *Urban runoff, *Water pollution sources, Chromium, Lead, Lindane, Polychlorinated biphenyls, Zinc.

Urban stormwater runoff has been identified as a source of pollution since the 1960's. Concentrations of polychlorinated biphenyls (PCBs), lindane, lead, zinc, and chromium at an outfall of a stormwater drain were analyzed during 3 rain events in 1988 and 1989. The catchment area covers 75 ha where about a quarter of the area is occupied by a commercial center. The rest of the area consists of single family housing. Mean concentrations in the stormwater runoff were 130 ng/L for PCBs and 75 ng/L for lindane. The mean concentration value for Pb was 140 microgram/L, while Zn and Cr had values of 730 microgram/L and 15 microgram/L. The source of these pollutants in the runoff were varied. While the atmosphere appeared to be only a minor source of PCBs, contaminated oils washed out from the commercial center appeared to be another source. A large portion of the Zn seemed to be autochthonous with the main sources being either traffic-related or due to exterior paints. The atmospheric contribution of Pb was important because a significant portion of particulate lead emitted from petrol combustion is dispersed into the atmosphere. A majority of the Cr appears to come from the atmosphere, and lindane was derived completely from atmospheric fallout. Further research is needed, notably on the impact of shock loads of pollutants to the receiving ecosystem. The occurrence of organic micropollutants in runoff should also be thoroughly investigated. (Korn-PTT)
W91-07847

KINETICS AND METABOLISM OF 14C-LINDANE AND 14C-ATRAZINE IN EARLY LIFE STAGES OF ZEBRAFISH (BRACHYDANIO RERIO).
Mainz Univ. (Germany, F.R.). Inst. fuer Zoologie.
G. Gorge, and R. Nagel.
Chemosphere CMSHAF, Vol. 21, No. 9, p 1125-1137, 1990. 6 fig, 4 tab, 27 ref.

Descriptors: *Atrazine, *Bioaccumulation, *Carbon radioisotopes, *Kinetics, *Lindane, *Metabolism, *Path of pollutants, *Zebra fish, Absorption, Fish eggs, Growth stages, Larvae, Pesticides.

Fertilized eggs, yolk sac larvae, and juveniles of zebrafish were exposed to 14-C-lindane and 14-C-atrazine under static conditions and the uptake was studied for a period of 48 hours. After 24 hours, a number of animals were transferred into pesticide-free running water and the elimination was examined for another 24 hours. The bioconcentration factors (BCFs) as well as the rate constants for uptake and elimination were calculated. Except for the lindane uptake by eggs and the atrazine uptake by juveniles, steady state conditions were reached within five hours. For all tested developmental stages the BCF of lindane distinctly exceeded 100, whereas it was less than 10 in cases of atrazine. More than 90% of the lindane content at steady state was eliminated within 24 hours, but only 70 to 85% of the incorporated atrazine. However, comparable amounts remained when related to body weight: approximately 2.3 micromole atrazine/kg and 3.4 micromole lindane/kg. Juvenile zebrafish metabolized 50% of the lindane and 4% of the atrazine within 40 hours. Two groups of metabolites were separated from the exposure medium: the ether-extractable and non-ether-extractable compounds. The metabolites were isolated by high performance liquid chromatography (HPLC). Nine and three metabolites were detected for lindane, and one and three metabolites were detected for atrazine in the ether-soluble fraction and the water-soluble fraction, respectively. (Author's abstract)
W91-07848

TREE RING GROWTH AND ELEMENTAL CONCENTRATIONS IN WOOD CORES OF OAK SPECIES IN EASTERN PENNSYLVANIA: POSSIBLE INFLUENCES OF AIR POLLUTION AND ACIDIC DEPOSITION.
Lafayette Coll., Easton, PA. Dept. of Biology.
S. K. Majumdar, J. R. Halma, S. W. Cline, D. Rieker, and C. Daehler.
Environmental Technology (Letters) ETLEDB, Vol. 12, No. 1, p 41-49, 1991. 7 fig, 41 ref.

Descriptors: *Acid rain effects, *Air pollution effects, *Heavy metals, *Oak, *Trees, Buffering, Chemical analysis, Forests, Growth, Hydrogen ion concentration, Pennsylvania, Soil chemistry, Solubility, Statistical analysis.

Annual growth ring patterns of red oak (Quercus rubra) and white oak (Q. alba) were compared from Lehigh Valley (near neutral soils) and the Pocono (acid soils) forests in eastern Pennsylvania. The two red oak populations were parallel, although statistically different, from 1935-1950. For white oak, the two populations had the same mean for the period of 1935-1965; and from 1965-1985 the means were different. Chemical analyses of wood cores had shown increasing concentrations of several trace elements in new rings of both oak species from the Lehigh Valley and the Pocono areas. These results apparently reflect the effects of acid precipitation on soil chemistry; that is, low pH increases the solubility and the concentrations of certain plant-available heavy metals in the soil. The acidic deposition is seemingly more severe in the less buffered Pocono soils than in the well buffered soils of the Lehigh Valley neutral pH areas. Although the results suggest certain changes in growth pattern and chemical composition in the wood cores, no clear-cut evidence that air pollution or acid rain was affecting the health of the two forests could be detected. (Author's abstract)
W91-07857

ACID EARTH: THE GLOBAL THREAT OF ACID POLLUTION.
J. McCormick.
Earthscan Publications Ltd., London. 1989. 225p.

Descriptors: *Acid rain, *Acid rain effects, *Acidification, *Air pollution, *Environmental protection, *Water pollution sources, England, Global precipitation, Nitrous oxide, Public policy, Sulfur dioxide, USSR, United States, Water quality.

Acid rain has become one of the quintessential global environmental issues. It has tested the ability of economic and political systems to respond to

the growing destruction of the environment, and shown how confused, divisive and piecemeal are those systems. This book was written as a response to this confusion. First published in 1985, it is a study of acid rain as both a global and/or public policy problem. It sets out to describe the dimensions of acid pollution and to assess the possible responses. It argues that acid rain--like many other environmental problems--has many dimensions, but that it is ultimately a political problem that can only be adequately addressed by changes in public policy. Since first published in 1985, perhaps three major efforts to combat acid rain stand out: (1) the United Kingdom reversed its position on acid rain, and is now committed to major reductions in sulfur dioxide and nitrogen oxides by the beginning of the next century; (2) there has been a change of attitude (if not yet in policy) in the Soviet Union, the biggest single source of acid pollution in the world; and (3) the public debate about acid pollution seems to have been by-passed to an extent by the new debates about the ozone layer and the greenhouse effect. Although many countries have now committed themselves to dealing with acid pollution, and although some have already cut their SO2 and NOx emissions by 25-50%, several issues remain: (1) whether all those countries which have promised to reduce their emissions actually meet their commitments; (2) will emission reductions of 25-50% be enough; (3) despite all the cutbacks in emissions, much damage has been done, and has still to show itself. What kind of long-term changes will appear in the next 20-30 years; (4) events in the Soviet Union not withstanding, emissions in some of the centrally planned economies are on the increase--between 1980 and 1984 Yugoslavian emissions grew by 53%, and between 1985 and 1990 Polish emissions are expected to grow by 20%--and it is not known whether these trends are reversible; and (5) the movement to win international agreement on emission reductions has so far centered almost exclusively on the industrialized world, and has all but ignored the less developed countries. But early estimates suggest the potential for major acid pollution problems in China, Malaysia, the Philippines, India, Brazil, Mexico and other countries. These are some of the issues addressed in this book. (Lantz-PTT)
W91-07903

PROCEEDINGS OF 10TH SALT-WATER INTRUSION MEETING.
For primary bibliographic entry see Field 2F.
W91-07947

HYDROCHEMICAL EVIDENCE OF FRESH AND SALT-WATER INTRUSIONS IN THE COASTAL DUNES AQUIFER SYSTEM OF THE WESTERN NETHERLANDS.
Keuringsinstituut voor Waterleidingartikelen, Rijswijk (Netherlands).
For primary bibliographic entry see Field 2F.
W91-07948

GROUNDWATER QUALITY IN THE TERTIARY LEDO-PANISELIAN AQUIFER IN BELGIUM AS A RESULT OF FRESH-WATER INTRUSION INTO SEDIMENTS IN CHEMICAL EQUILIBRIUM WITH THE SEA.
Ghent Rijksuniversiteit (Belgium). Lab. for Applied Geology and Hydrogeology.
For primary bibliographic entry see Field 2K.
W91-07949

GROUNDWATER IN BEKASI DISTRICT, WEST JAVA, INDONESIA.
Iwaco B.V., Rotterdam (Netherlands).
For primary bibliographic entry see Field 4B.
W91-07950

HYDROCHEMICAL STUDY OF A CROSS-SECTION THROUGH THE COASTAL PLAIN AND ITS SURROUNDINGS NEAR THE FRENCH-BELGIAN BORDER.
Ghent Rijksuniversiteit (Belgium). Lab. for Applied Geology and Hydrogeology.
For primary bibliographic entry see Field 2K.
W91-07951

ORIGIN AND AGE OF COASTAL GROUNDWATERS IN NORTHERN OMAN.
Paris-11 Univ., Orsay (France). Lab. d'Hydrologie et de Geochemie Isotopique.
I. D. Clark, P. Ravenscroft, and P. Fritz.
IN: Proceedings of 10th Salt-Water Intrusion Meeting. Geologisch Instituut R.U.G. (S 8), Ghent. 1989. p 75-84. 12 fig, 22 ref.

Descriptors: *Alluvial aquifers, *Coastal aquifers, *Groundwater recharge, *Groundwater resources, *Oman, *Saline water intrusion, Confined aquifers, Connate water, Groundwater movement, Isotope studies, Rainfall-runoff relationships, Tracers, Water circulation.

The coastal plain of northern Oman, bounded by the Gulf of Oman to the northeast and the Northern Oman Mountains to the southwest, is the most intensively cultivated area in the Sultanate. Heavy extraction from the alluvial aquifers for irrigation is linked to recent saline intrusion and groundwater deterioration. The origins and mean circulation times of coastal groundwaters were investigated to better understand the mechanisms and frequency of recharge of coastal aquifers. Stable isotopes (18-O and 2-H) show that localized convective rainfall in the mountains and piedmont during hot months, identified by a characteristic evaporative enrichment, dominates recharge to shallow coastal groundwaters. The less frequent but larger depression-rainfall systems of winter months, which show no isotope enrichment, is evident only in the deeper confined aquifers, recharged at higher elevations. Mean circulation times, evaluated on the basis of tritium and 14-C data, are less than about 5 years for shallow alluvial groundwaters associated with the active runoff network. In interfluvial areas they may be some tens to hundreds of years. Deep confined groundwaters are in the order of several thousands of years. Saline intrusion is occurring in both the shallow and deep coastal groundwaters. Possible mixing with an older connate brine is identified in the deeper coastal zone of one area, which may exacerbate groundwater deterioration. (See also W91-07947) (Author's abstract)
W91-07953

HYDROCHEMISTRY OF PORE WATER FROM FINE-GRAINED SEDIMENTS (CLAY, SILT, PEAT) IN THE SOUTHERN PART OF THE WESTERN BELGIAN COASTAL PLAIN: THE YSER PLAIN.
Ghent Rijksuniversiteit (Belgium). Lab. for Applied Geology and Hydrogeology.
For primary bibliographic entry see Field 2G.
W91-07955

PARTRAC: DEVELOPMENT AND APPLICATION OF A GROUNDWATER-QUALITY MODEL FOR VARIABLE DENSITY FLOW.
GRONTMIJ N.V., De Bilt (Netherlands).
L. A. M. Besselink.
IN: Proceedings of 10th Salt-Water Intrusion Meeting. Geologisch Instituut R.U.G. (S 8), Ghent. 1989. p 109-116, 6 fig, 8 ref.

Descriptors: *Computer models, *Groundwater movement, *Groundwater quality, *Model studies, *Path of pollutants, *Solute transport, *Vertical flow, Freshwater, Groundwater pollution, Porous media, Saline groundwater, Saline water intrusion, Saline-freshwater interfaces, Upconing.

A groundwater flow model has been developed for both fresh, saline, and polluted groundwater problems in a vertical profile. The model is a tool for the explanation and forecasting of transport phenomena in porous media. The characteristics of the model PARTRAC include: pressure field calculated with the finite element method; quasi-steady conditions; solute transport simulated by particle tracking; concentrations defined per element; molecular diffusion and hydrodynamic dispersion simulated with the random walk method; first-order decay; linear adsorption; density-dependent flow; non-numerical dispersion; and interactive procedure for generation of an input-file with a mesh generator. In this model the velocity field, which is of great importance for transport phenomena through porous media, is defined in a new manner. The model was calibrated with various theoretical test-cases, including: intrusion of salt seawater under a dike with a sheet pile; upconing below a well pumping above an interface between fresh and salt groundwater; and the problem of the initial vertical sharp interface between fresh and saline groundwater. (See also W91-07947) (Author's abstract)
W91-07956

PREDICTION OF THE CHLORIDE CONTENT IN THE ABSTRACTED WATER OF THE 'DE GROEVE' WELL FIELD.
Keuringsinstituut voor Waterleidingartikelen, Rijswijk (Netherlands).
For primary bibliographic entry see Field 2F.
W91-07960

COMPARISON OF DIFFERENT METHODS FOR REPRESENTING THE HYDRODYNAMIC TENSOR IN NUMERICAL MODELS.
Hydraulics Research Ltd., Wallingford (England).
For primary bibliographic entry see Field 2F.
W91-07961

EXPERIMENTS ON THE MOVEMENT OF BRACKISH WATER NEAR INFILTRATION AND ABSTRACTION WELLS.
Waterworks of North-Holland, Bloemendaal (Netherlands).
For primary bibliographic entry see Field 2F.
W91-07963

DEVELOPMENT OF A KNOWLEDGE SYSTEM FOR MODELLING FRESH AND SALINE-GROUNDWATER FLOW.
Technische Hogeschool Delft (Netherlands). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2F.
W91-07964

APPLICATION OF THE FACTOR-ANALYSIS METHOD TO STUDY THE ORIGIN AND EVOLUTION OF THE SALINIZATION IN THE AQUIFER SYSTEM NO. 25 (HUELVA PROVINCE, SPAIN).
Escuela Univ. Politecnica de la Rabida, Huelva (Spain). Dept. de Geologia.
For primary bibliographic entry see Field 2F.
W91-07966

FRESH AND SALT-WATER INTRUSION: LABORATORY EXPERIMENTS AND GEOCHEMICAL TRANSPORT MODELLING.
Vrije Univ., Amsterdam (Netherlands). Inst. voor Aardwetenschappen.
For primary bibliographic entry see Field 2F.
W91-07969

ISOTOPE STUDIES OF THE HYDROLOGY OF THE GORLEBEN AREA, FRG.
Bundesanstalt fuer Geowissenschaften und Rohstoffe, Hanover (Germany, F.R.).
For primary bibliographic entry see Field 2F.
W91-07970

PROCESSES IN THE MIXING ZONE IN CARBONATE FORMATIONS: CENTRAL AND SOUTHERN CATALONIA.
Universidad Politecnica de Cataluna, Barcelona (Spain). Escuela Tecnica Superior de Ingenieros de Caminos, Canales y Puertos.
For primary bibliographic entry see Field 2F.
W91-07971

TOOLS FOR INVESTIGATING THE ORIGIN OF ANOMALIES IN CHLORIDE CONTENT OF GROUNDWATER IN COASTAL LOWLANDS.
Institute of Applied Geoscience TNO, Delft (Netherlands).
For primary bibliographic entry see Field 2F.
W91-07972

SOME PROCESSES IN THE SEA-WATER/FRESH-WATER INTERFACE, AS INFLUENCED BY THE PRESENCE OF GASES.
Calgary Univ. (Alberta). Dept. of Geology and Geophysics.
For primary bibliographic entry see Field 2F.
W91-07973

ESTIMATION OF THE LATERAL DISPERSIVITY IN A HOMOGENEOUS ISOTROPIC COASTAL AQUIFER.
Lund Univ. (Sweden). Dept. of Water Resources Engineering.
For primary bibliographic entry see Field 2F.
W91-07974

TEMPERATURE OF GROUNDWATERS IN COASTAL AQUIFERS: SOME ASPECTS CONCERNING SALT-WATER INTRUSION.
Bari Univ. (Italy). Ist. di Geologia Applicata e Geotecnia.
For primary bibliographic entry see Field 2F.
W91-07975

CHEMICAL AND ISOTOPICAL METHODOLOGIES IN THE STUDIES ON ORIGIN AND EVOLUTION OF GROUNDWATERS FLOWING IN THE COASTAL CARBONATE AND KARST AQUIFER OF APULIA (SOUTHERN ITALY).
Palermo Univ. (Italy). Ist. di Mineralogia.
For primary bibliographic entry see Field 2F.
W91-07976

DETECTION OF FRESH-WATER/SEA-WATER INTERFACE BY THE TIME DOMAIN ELECTROMAGNETIC (TDEM) METHOD IN ISRAEL.
Institute for Petroleum Research and Geophysics, Holon (Israel).
M. Goldman, A. Arad, U. Kafri, D. Gilad, and A. Melloul.
IN: Proceedings of 10th Salt-Water Intrusion Meeting. Geologisch Instituut R.U.G. (S 8), Ghent. 1989. p 329-344, 18 fig, 1 tab, 7 ref.

Descriptors: *Coastal aquifers, *Geophysical methods, *Israel, *Resistivity, *Saline water intrusion, *Saline-freshwater interfaces, Aquifers, Electrical equipment, Interstitial water, Saline groundwater.

The resistivity of water-bearing rocks is a function of the water content, the water salinity, and the manner in which the water is distributed throughout the rock. These relationships infer that the resistivity of the formation decreases as the salinity of the pore water increases. This phenomenon allows use of surface electrical and/or electromagnetic methods to map changes in groundwater salinity, and in particular, to detect a fresh/saline water interface. A feasibility study on the applicability of the time domain electromagnetic (TDEM) method in detecting seawater intrusion into freshwater aquifers was carried out on an Israeli coastal plain. It was found that absolute resistivity values varying between 0.5-1.5 ohm-m are typical of seawater intrusion. These are different from any other resistivity values which stem from other known lithology and/or water-salinity combinations. The TDEM method has proved to be a reasonably accurate technique for detection of freshwater/seawater interfaces in carbonate, and particularly coastal aquifers. (See also W91-07947) (Fish-PTT)
W91-07977

SALT-WATER INTRUSION MONITORING BY RESISTIVITY AND IP-TOMOGRAPHIC METHODS.
Politecnico di Torino (Italy). Dipt. di Georisorse e Territorio.
G. Ranieri, G. Barrocu, and R. Tocco.
IN: Proceedings of 10th Salt-Water Intrusion Meeting. Geologisch Instituut R.U.G. (S 8), Ghent. 1989. p 345-348, 4 fig, 6 ref.

Descriptors: *Coastal aquifers, *Geophysical methods, *Resistivity, *Saline water intrusion, *Tomography, Conductivity, Electrical equipment, Saline-freshwater interfaces.

Tomographic techniques are currently almost exclusively used in the field of seismology. The possibilities of applying them to geo-electrical methods have been examined. A method of approximately representing the real model without an initial one has been developed, consisting of evaluating the mean value of the physical greatness taken into account in an area of prefixed dimensions by simply considering a regular and average distribution along the lines connecting source and receiving apparatus. In order to organize a system to monitor saltwater intrusion in fresh groundwater, the method was applied in a laboratory to two different models, representing (1) differing conductivity, resistivity and chargeability tomography, and (2) a real saltwater encroachment situation. The saltwater intrusion zone was clearly outlined in both tomographies; it is represented by a minimum in the resistivity tomography and by negative values contoured by high positive values due to diffusion zones in the chargeability tomography. The system is recommended to univocally solve resistivity and IP-tomographic problems to define and monitor, in real time, seawater intrusion zones. (See also W91-07947) (Fish-PTT)
W91-07978

BENTHIC MACROFAUNA OF OX-BOW LAKES AND THE INFLUENCE ON THE MACROINVERTEBRATE COMMUNITIES OF THE PARENT STREAM.
Technische Univ. Braunschweig (Germany, F.R.). Zoologisches Inst.
For primary bibliographic entry see Field 2H.
W91-07991

ORGANOCHLORINE PESTICIDES IN SOIL SEDIMENTS AND AQUATIC ANIMALS IN THE UPPER STEELE BAYOU WATERSHED OF MISSISSIPPI.
Mississippi Cooperative Fish and Wildlife Research Unit, Mississippi State.
W. M. Ford, and E. P. Hill.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 20, No. 2, p 161-167, February 1991. 2 fig, 3 tab, 25 ref.

Descriptors: *Aquatic animals, *Fate of pollutants, *Mississippi, *Organochlorine pesticides, *Path of pollutants, *Pesticide residues, *Sediment contamination, *Water pollution, Bioaccumulation, Biological magnification, Fish, Upper Steele Bayou Watershed, Yazoo National Wildlife Refuge.

Soil sediments from two depths and tissue samples from eight species of aquatic animals were collected on or near Yazoo National Wildlife Refuge, Mississippi, and analyzed for organochlorine pesticide residues. Residues of 12 organochlorine pesticides were found in most animal samples, and 0.0 to 4.6 mg/kg of five compounds were detected in soil sediments. With the exception of mosquitofish (Gambusia affinis), residues were similarly distributed in soil and animal samples among different watercourses within the watershed. Biomagnification of organochlorine pesticide residues was evident from soil sediments to mosquitofish, a lower secondary consumer and forage fish, to spotted gar (Lepisosteus oculatus), a tertiary consumer. Residues in larger secondary consumers such as carp (Cyprinus carpio) and smallmouth buffalo (Ictiobus bubalus) and tertiary consumers such as water snakes (Nerodia spp.) and cottonmouths (Agkistrodon piscivorus) demonstrated no clear patterns of accumulation. (Author's abstract)
W91-07997

TOXIC ELEMENT CONTAMINATION AND THE OCCURRENCE OF MERCURY-RESISTANT BACTERIA IN HG-CONTAMINATED SOIL, SEDIMENTS, AND SLUDGES.
California Univ., Irvine.
B. H. Olson, S. M. Cayless, S. Ford, and J. N. Lester.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 20, No. 2, p 226-233, February 1991. 3 fig, 5 tab, 43 ref.

Descriptors: *Bacteria, *Mercury, *Methylmercury, *Path of pollutants, *Sediment contamination, *Sludge, *Soil contamination, *Toxicity, Bacterial physiology, DNA, England, Heavy metals, Norfolk, River Yare, River sediments.

Sludge samples were collected from a sewage treatment works which received Hg-contaminated effluent, soil was sampled from land treated with the sludge, and freshwater sediment samples were obtained from the River Yare, Norfolk, England, which receives the final effluent from the sewage treatment works. Samples were analyzed for Hg, MeHg, Cd, Cr, Cu, Ni, Pb, and Zn. Volatile solids, chloride, sulfate, and sulfide were also assessed. Heavy metal contamination was present in all the samples, particularly soil and sediment. The conditional stability constants values for Cu were less than those for Hg and lower for soil than for river sediment. Complexation may be a major factor in Hg methylation as high conditional stability constants reflected low MeHg levels. High chloride concentration was also associated with low ratios of methyl to total Hg. Using DNA probe technology, the occurrence of DNA sequences typical of transposons Tn21 and Tn501 were determined for bacteria isolated at the different sites. Observable (phenotypic) Hg resistance was greatest at sites of high Hg and chloride concentrations although genetic variation was greatest in soil and sediment samples with lower Hg concentrations. Isolation of Tn501-like elements increased when Hg was added to the medium. Mercury resistance systems which are not homologous at high stringency to the mer operon appear to be common in soil, activated sludge, and river sediments. (Author's abstract)
W91-08003

LEAD, CADMIUM, AND ALUMINUM ACCUMULATION IN THE RED SWAMP CRAYFISH PROCAMBARUS CLARKII G. COLLECTED FROM ROADSIDE DRAINAGE DITCHES IN LOUISIANA.
Widener Univ., Chester, PA. Dept. of Biology.
S. R. Madigosky, X. Alvarez-Hernandez, and J. Glass.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 20, No. 2, p 253-258, February 1991. 1 fig, 4 tab, 25 ref. U.S. Public Health Service Grant DK-37866.

Descriptors: *Bioaccumulation, *Crustaceans, *Heavy metals, *Metals, *Path of pollutants, Aluminum, Cadmium, Crayfish, Food webs, Highway effects, Lead, Louisiana, Roads, Shoulder ditches, Tissue analysis, Toxic metals, Water pollution sources.

The concentrations of Pb, Cd, and Al in tissues of crayfish Procambarus clarkii were evaluated from several wetland sites located adjacent to roadways and were compared to crayfish harvested from a commercial site free from roadside influences. Abdominal muscle, hepatopancreas, alimentary tract, exoskeleton and blood were analyzed for metal content. Results indicated that levels of metal contamination obtained in almost all tissues of crayfish from roadside ditches were significantly greater than those of the commercially harvested control crayfish. The concentrations of metals detected in crayfish tissues ranged from 0.04-16.15 microg Pb/g, 0.001-0.13 microg Cd/g, and 1.22-981 microg Al/g. Concentrations of Pb, Cd, and Al were highest in the hepatopancreas and alimentary tract. High levels of these elements were also detected in the exoskeleton. In contrast, muscle tissue was the least affected tissue. It is concluded that P. clarkii sequesters and maintains substantial amounts of Al, Pb and Cd in a variety of tissues without lethal consequences, and thus may become a potential health hazard to humans and other organisms that use these crustaceans as a food source. (Author's abstract)
W91-08006

PARAMETERS FOR PREDICTING FATE OF ORGANOCHLORINE PESTICIDES IN THE ENVIRONMENT: III. BIODEGRADATION RATE CONSTANTS.
Yokohama National Univ. (Japan). Dept. of Material Science and Chemical Engineering.
K. Kawamoto, and K. Urano.

Chemosphere CMSHAF, Vol. 21, No. 10/11, p 1141-1152, 1990. 10 fig, 3 tab, 12 ref.

Descriptors: *Biodegradation, *Fate of pollutants, *Organochlorine pesticides, *Pesticides, Aerobic digestion, Anaerobic digestion, Half-life, Herbicides, Rate constants.

Aerobic and anaerobic biodegradation rate constants of 10 principal organochlorine pesticides were investigated to predict their fate in the environment. The biodegradation rate can be expressed by the first order rate equation. There was a large variation in the values of the rate constants; the half-lives for aerobic biodegradation of thiobencarb, chlornitrofen and fenvalerate ranged from 10 to 40 days, whereas the half-lives of chloropicrin and chlorothalonil were 10 and 11 hours, respectively. DCIP did not biodegrade within the experimental period of 40 days. The degradation rates of herbicides tended to be low. The half-lives for anaerobic biodegradation ranged from 0.06 to 100 days. The hydrophobicity of the pesticide and the presence of functional groups easily transferred by microorganisms appeared to affect the biodegradation rate. (See also W90-00480) (MacKeen-PTT)
W91-08015

PREDICTION OF THE SOIL ADSORPTION COEFFICIENT KOC FOR AROMATIC POLLUTANTS.
Institut de Recherches Chimiques, Tervuren (Belgium).
L. Pussemier, G. Szabo, and R. A. Bulman.
Chemosphere CMSHAF, Vol. 21, No. 10/11, p 1199-1212, 1990. 5 tab, 18 ref.

Descriptors: *Adsorption, *Aromatic compounds, *Fate of pollutants, *Path of pollutants, *Soil contamination, Hydrophobic compounds, Mathematical analysis, Soil absorption capacity, Soil chemistry, Soil organic matter.

The soil adsorption factor, Koc, has been predicted for 11 aromatic compounds using a multilinear relation with the log of the octanol/water partition coefficient (Kow) and Hildebrand's solubility parameter. Considered individually, log Kow was not the best hydrophobicity parameter for the prediction of Koc. Other molecular parameters such as the parachor, the van der Waals volume, or retention factors by reversed phase HPLC gave better predictions of Koc. However, using log Kow with Hildebrand's solubility parameter as a second independent variable offered better predictions. Moreover, all the retention factors could be used as the first independent variable. The gain in significance for these relations was most important with the apolar stationary phases. It is concluded that the adsorption on soil organic material is not simply due to hydrophobic interactions, but it also a result of weak electronic interactions between moderately polar species. (MacKeen-PTT)
W91-08019

ESTIMATION OF AQUEOUS SOLUBILITY AND MELTING POINT OF PCB CONGENERS.
Oregon State Univ., Corvallis. Coll. of Pharmacy.
R. Abramowitz, and S. H. Yalkowsky.
Chemosphere CMSHAF, Vol. 21, No. 10/11, p 1221-1229, 1990. 4 fig, 1 tab, 13 ref.

Descriptors: *Chlorinated hydrocarbons, *Mathematical analysis, *Path of pollutants, *Polychlorinated biphenyls, *Solubility, Estimating equations, Mathematical equations, Melting point.

A simple method has been developed to estimate the solubility of 208 polychlorinated biphenyl (PCB) congeners based on estimating the melting point of the compound and the total surface area. The melting points of 58 PCB congeners were correlated with the number of chlorine atoms in the molecule, along with molecular properties such as eccentricity and symmetry. Results indicated that the calculation of the melting point of a PCB molecule is influenced by the symmetry and the hindered rotation of substituent groups. Good agreement between calculated melting point and actual melting point was obtained. The predicted melting points were subsequently used to predict the solubility of the PCB congeners. In an analysis of 42 PCBs, it was found that the predicted melting point could be used in place of the actual melting point to estimate the solubility of PCBs. (MacKeen-PTT)
W91-08021

REVIEW OF BIODEGRADATION KINETICS IN THE AQUATIC ENVIRONMENT.
Water Research Centre, Medmenham (England).
N. S. Battersby.
Chemosphere CMSHAF, Vol. 21, No. 10/11, p 1243-1284, 1990. 4 fig, 5 tab, 126 ref.

Descriptors: *Analytical methods, *Biodegradation, *Fate of pollutants, *Kinetics, *Mathematical models, *Model studies, Aquatic environment, Literature review, Mathematical equations, Rate constants, Testing procedures.

Published expressions for the kinetics of biodegradation are reviewed. Much of the published work in the determination of biodegradation rates has involved relatively simple experimental procedures which produce data on the rate of decrease in the test substance or increase in products (e.g. carbon dioxide). Kinetic models used to describe biodegradation include: (1) first-order reactions, in which the rate of biodegradation is proportional to the concentration of one reactant, the test chemical; (2) Monod growth, co-metabolism and second-order kinetics, in which the growth rate of bacteria is a hyperbolic function of substrate concentration and approaches a maximum at high concentrations; and (3) Michaelis-Menten kinetics, heterotrophic uptake studies and specific activity indices, in which a pseudo first-order rate constant is dependent upon enzyme concentration, which in turn is affected by the concentration of active bacteria in the system. The integrated Monad equation and the Michaelis-Menten equation are the bases for two useful approaches for determining the most appropriate kinetic expression to apply to a set of biodegradation data. An analysis of the 'ready biodegradability' test of the Organization for Economic Cooperation and European Economic Community Sixth Amendment indicated a lack of agreement between test data and actual rate of biodegradation in a variety of aquatic environments, in part due to the unrealistically high substrate concentrations used in the test. Environmentally realistic test conditions were suggested, in which an environmental sample is amended with a small amount of uniformly (C-14)-labelled test chemical and the change with time in C-14 content is measured in particulate, evolved carbon dioxide, and/or solution fractions. (MacKeen-PTT)
W91-08022

EFFECTS OF ACID PRECIPITATION RUNOFF EPISODES ON RESERVOIR AND TAPWATER QUALITY IN AN APPALACHIAN MOUNTAIN WATER SUPPLY.
Pennsylvania State Univ., University Park. Environmental Resources Research Inst.
W. E. Sharpe, and D. R. DeWalle.
Environmental Health Perspectives EVHPAZ, Vol. 89, p 153-158, November 1990. 6 fig, 2 tab, 18 ref.

Descriptors: *Acid rain, *Acid rain effects, *Appalachian Mountains, *Drinking water, *Path of pollutants, *Water pollution sources, *Water supply, Acidic water, Acidification, Aluminum, Copper, Hydrogen ion concentration, Lead, Pennsylvania, Reservoirs, Water quality, Water quality trends.

The aluminum concentration and Ryznar Index increased and the pH decreased in a small Appalachian water supply reservoir following acid precipitation runoff episodes. Concomitant increases in tapwater aluminum and decreases in tapwater pH were also observed at two homes in the water distribution system. Lead concentrations in the tapwater of one home frequently exceeded recommended levels, although spatial and temporal variation in tapwater copper and lead concentrations was considerable. Since source water and reservoir water copper and lead concentrations were much lower, the increased copper and lead concentrations in tapwater were attributed to corrosion of household plumbing. Tapwater copper concentration correlated well with tapwater pH and tapwater temperature. Asbestos fibers were not detected in tapwater. The asbestos-cement pipe in the water distribution system was protected by a spontaneous metallic coating that inhibited fiber release from the pipe. Several simultaneous reactions were hypothesized to be taking place in the distribution system that involved corrosion of metallic components and coating of asbestos-cement pipe components in part with corrosion products and in part by cations of watershed origin. Greater water quality changes might be expected in areas of higher atmospheric deposition. (Author's abstract)
W91-08025

SCAVENGING OF SO2 BY CLOUD AND RAIN DROPS: IV. A WIND TUNNEL AND THEORETICAL STUDY OF THE ABSORPTION OF SO2 IN THE PPB(V) RANGE BY WATER DROPS IN THE PRESENCE OF H2O2.
Mainz Univ. (Germany, F.R.). Inst. of Meteorologie.
A. Waltrop, S. K. Mitra, A. I. Flossmann, and H. R. Pruppacher.
Journal of Atmospheric Chemistry JATCE2, Vol. 12, No. 1, p 1-17, January 1991. 6 fig, 20 ref. Ministry for Research and Technology of the Federal Republic of Germany Project 325-4007-070458. German Science Foundation Project SFB-233.

Descriptors: *Acid rain, *Chemistry of precipitation, *Hydrogen peroxide, *Path of pollutants, *Precipitation scavenging, *Sulfur dioxide, Absorption, Acidification, Diffusion, Fluid drops, Hydrogen ion concentration, Sulfates.

Involving the Mainz vertical wind tunnel, the rate of sulfur dioxide removed from the air by freely suspended water drops was measured for sulfur dioxide concentrations in the gas phase ranging from 50 to 500 ppb, and for various hydrogen peroxide concentrations in the liquid phase. In a first set of experiments, the pH inside the sulfur dioxide absorbing drops was monitored by means of color indicators added to the drops. In a second set of experiments, the amount of sulfur dioxide scavenged by the drops was determined as sulfate by an ion chromograph after the drops had been removed from the vertical air stream of the wind tunnel after various times of exposure to sulfur dioxide. The results were compared with the theoretical gas diffusion model of Walcek and Pruppacher which was reformulated for the case of sulfur dioxide concentrations in the ppb(v) range for which the main resistance to diffusion lies in the gas phase surrounding the drop. Excellent agreement between experiment and theory was obtained. The theory was used to investigate the rate of sulfate production inside a drop as a function of pH. It was found that the production rate increases rapidly at first, eventually goes through a maximum and, subsequently, after a small decrease, levels out to an almost constant value. The results further suggest that the mass accommodation coefficient for sulfur dioxide and hydrogen peroxide on aqueous surfaces is near unity. (Author's abstract)
W91-08038

SEASONAL AND WEATHER-RELATED CONTROLS ON SOLUTE CONCENTRATIONS AND ACID DRAINAGE FROM A PYRITIC COAL-REFUSE DEPOSIT IN SOUTHWESTERN INDIANA, U.S.A.
Indiana Univ. at Bloomington. Dept. of Geological Sciences.
G. A. Olyphant, E. R. Bayless, and D. Harper.
Journal of Contaminant Hydrology JCOHE6, Vol. 7, No. 3, p 219-236, February 1991. 13 fig, 2 tab, 21 ref.

Descriptors: *Acid mine drainage, *Dissolved solids, *Indiana, *Path of pollutants, *Small watersheds, *Solute transport, Coal wastes, Iron, Seasonal variation, Sulfates, Water chemistry, Water quality monitoring.

A small watershed on a barren deposit of pyritic coal refuse was instrumented and intensively moni-

tored for 15 months to determine characteristics of acid runoff, and seasonal and weather-related trends in subsurface aqueous chemistry. Pore waters are most contaminated in the shallow (<1 m) subsurface, where total dissolved solids (TDS, mostly sulfate and iron) sometimes exceed 160,000 mg/L. Chemical fluctuations, which are related to changes in moisture content, are extreme, and concentrations of TDS range across more than an order of magnitude during the course of a water year. In contrast, lower concentrations of TDS (<65,000 mg/L) are consistently observed below the water table. Samples of overland flow contain concentrations of TDS as high as 8260 mg/L. Surface runoff is acidified by dissolution of hydrated iron sulfate minerals. These salts, which are ubiquitous on the ground surface and in shallow capillary pathways, are evidence of a strong hydrologic connection between the unsaturated zone and the surface. Preliminary calculations indicate that acidic outflow by surface runoff constitutes a major portion of the total acid drainage from the coarse-refuse deposit. (Author's abstract)
W91-08040

COSORPTION OF AROMATIC N-HETEROCYCLES AND PYRENE BY SMECTITES IN AQUEOUS SOLUTIONS.
Ohio State Univ., Columbus. Dept. of Agronomy.
S. J. Traina, and B. M. Onken.
Journal of Contaminant Hydrology JCOHE6, Vol. 7, No. 3, p 237-259, February 1991. 11 fig, 30 ref. U.S. Geological Survey Grant 14-08-0001-G1607.

Descriptors: *Organic compounds, *Path of pollutants, *Polycyclic aromatic hydrocarbons, *Smectite, *Solute transport, *Sorption, Adsorption, Clays, Hydrogen ion concentration, Isotherms, Pyrene, Quinaline.

The simultaneous sorption of the polycyclic aromatic hydrocarbon pyrene and the aromatic N-heterocycles quinoline and acridine by aqueous suspensions of either Na-montmorillonite or Na-hectorite was examined. In all cases, pyrene sorption in the absence of sorbed N-heterocycles was not detected. In the presence of sorbed N-heterocycles, pyrene sorption increased with increased surface concentrations of quinoline of acridine. The pH-dependent sorption of quinoline and acridine caused an apparent pH dependence in pyrene sorption. Fluorescence emission spectra indicated that the acridinium ion was the dominant form of sorbed acridine on hectorite. Fluorescence emission spectra of pyrene, cosorbed with quinoline by hectorite, indicated that the surface-bound pyrene resided in an environment of lower polarity than bulk water. A linear isotherm for pyrene sorption on Na-montmorillonite was obtained at a quinoline surface concentration of 27.19 cmol/kg, while the pyrene sorption isotherm was curvilinear when there was only 4.67 cmol/kg quinoline present on the clay surface. In all experiments, the value of Koc for pyrene sorption decreased with increased surface concentrations of N-heterocycles. It is postulated that pyrene sorption at low concentrations of quinoline or acridine is due to adsorption of pyrene by sorbed N-heterocycles. Increased concentrations of quinoline or acridine promote sorption of pyrene through a partition reaction with sorbed N-heterocycles. (Author's abstract)
W91-08041

FLUID FLOW AND SOLUTE TRANSPORT PROCESSES IN UNSATURATED HETEROGENEOUS SOILS: PRELIMINARY NUMERICAL EXPERIMENTS.
Hawaii Univ. at Manoa, Honolulu. Dept. of Civil Engineering.
C. C. K. Liu, K. Loague, and J.-S. Feng.
Journal of Contaminant Hydrology JCOHE6, Vol. 7, No. 3, p 261-283, February 1991. 10 fig, 4 tab, 26 ref. U.S. Geological Survey Grant 14-08-0001-G1489.

Descriptors: *Aeration zone, *Fluid flow, *Numerical analysis, *Path of pollutants, *Soil properties, *Soil water, *Solute transport, *Unsaturated flow, Dispersivity, Heterogeneous soils, Porous media, Scale factors, Three-dimensional model, Unsaturated soils.

Preliminary numerical experiments were conducted to investigate scale-dependent macrodispersivity, relative to solute transport, in unsaturated heterogeneous porous media. Synthetic heterogeneous soil columns were generated with the turning bands approach. Fluid flow and solute transport were simulated with a three-dimensional finite-element model. Numerical experiments confirmed a three-phase development of macrodispersivity as a plume of contaminant moves through a heterogeneous soil. The initial phase grows linearly, then becomes nonlinear, and eventually reaches an asymptotic constant value. It was found that the development of macrodispersivity in an unsaturated heterogeneous soil column can be predicted successfully by Dagan's formulas, which were originally developed for heterogeneous aquifers. For the study of contaminant transport in unsaturated soils, the travel distance normally considered is much shorter than that required to reach asymptotic macrodispersivity; thus, the two pre-asymptotic phases should be the principal concern in modelling contaminant transport in unsaturated soils. The first phase of the macrodispersivity development corresponds to what is normally referred to as the advection period during which no significant lateral mixing takes place. The linear system model for contaminant transport, which uses the travel time probability density function as the model's impulse response function, is valid only for the first phase and therefore should be applied only to the simulation of near-field contaminant transport within the advection period. (Author's abstract)
W91-08042

IMPORTANCE OF CLOSELY SPACED VERTICAL SAMPLING IN DELINEATING CHEMICAL AND MICROBIOLOGICAL GRADIENTS IN GROUNDWATER STUDIES.
Geological Survey, Lakewood, CO. Water Resources Div.
For primary bibliographic entry see Field 5A.
W91-08043

TOXICITY, BIOACCUMULATION, METABOLISM AND ELIMINATION OF DIOCTYL SODIUM SULFOSUCCINATE DSS IN RAINBOW TROUT (ONCORHYNCHUS MYKISS).
NIEHS Marine and Freshwater Biomedical Core Center, Milwaukee, WI.
M. S. Goodrich, M. J. Melancon, R. A. Davis, and J. J. Lech.
Water Research WATRAG, Vol. 25, No. 2, p 119-124, February 1991. 4 fig, 4 tab, 16 ref. NIH Grants ES01080 and ES04184.

Descriptors: *Bioaccumulation, *Fish physiology, *Metabolism, *Surfactants, *Toxicity, *Toxicology, *Trout, Biological magnification, Blood, Carbon radioisotopes, Excretion, Fish, Kinetics, Tissue analysis.

The acute toxicity (LC50) of the anionic surfactant dioctyl sodium sulfosuccinate (DSS) was determined to be 28 mg/L in rainbow trout. A static non-replacement exposure of rainbow trout to C14-labeled DSS was used to measure the bioaccumulation and elimination of DSS within four separate body compartments: blood, biie, viscera, and carcass. The trout were exposed for 72 h followed by 72 h for depuration. Tissue samples were analyzed at 2, 4, 12, 24, 48, and 72 h during both the exposure and depuration phases of the experiment. Using scintillation counting, DSS concentrations were measured in tissues and used to calculate uptake rate constants, bioconcentration factors, elimination rate constants, and half-lives of DSS elimination for each body compartment. The greatest rate of appearance of DSS was in the bile of the trout, while the slowest uptake occurred within the carcass. Elimination of DSS from the carcass and viscera of the trout was found to follow second order kinetics, while elimination from the blood and bile followed first order kinetics. The evaluation of (C14)DSS metabolism was conducted using the HPLC analysis of biliary metabolites following an intraperitoneal injection. Two major peaks were found containing C14 that were not associated with the parent DSS peak. (Author's abstract)
W91-08045

BIODEGRADATION AND ANTICHOLINESTERASE ACTIVITY OF METHYL ISOCYANATE IN THE AQUATIC ENVIRONMENT OF BHOPAL.
National Inst. of Oceanography, Panaji (India).
For primary bibliographic entry see Field 5C.
W91-08052

EFFECT OF CARBON DIOXIDE EQUILIBRIUM ON PH IN DILUTE LAKES.
Cornell Univ., Ithaca, NY. School of Civil and Environmental Engineering.
For primary bibliographic entry see Field 2H.
W91-08053

FATE AND TRANSPORT OF THE EXXON VALDEZ OIL SPILL.
National Oceanic and Atmospheric Administration, Seattle, WA.
J. A. Galt, W. J. Lehr, and D. L. Payton.
Environmental Science and Technology ESTHAG, Vol. 25, No. 2, p 202-209, February 1991. 6 fig, 9 ref.

Descriptors: *Alaska, *Exxon Valdez, *Fate of pollutants, *Oil, *Oil pollution, *Oil spills, *Path of pollutants, Crude oil, Disasters, Dispersion, Distribution patterns, Estuarine environment, Oil tankers, Oil-water interfaces, Oily water, Prince William Sound.

In the early hours of March 24, 1989, the tanker Exxon Valdez ran aground on Bligh Reef in Prince William Sound, Alaska, releasing a quarter million barrels of North Slope crude oil into the surrounding waters. The major physical processes of the dispersion were gravity and surface tension as well as evaporation of the lighter hydrocarbons by surface transfer. On the third day of the spill, the region experienced a major wind storm which had a profound effect on the spill and dramatically changed its appearance, character and distribution. The first effect was to rupture the more or less contiguous slick into bands and streaks over a large area. The second effect was to enhance evaporation. The third major effect of the storm was to mix the oil with water to form an emulsion (mousse) which greatly increased the volume of material likely to stick on beaches. Reports on the movement of the slick from trained observers and and remote sensing devices were compared with computer models of wind and current conditions to construct a model of the history and coverage of the spill. By mid April, only widely scattered patches of mousse were observed, with the exception of a convergence zone that was formed by currents south of Cape Douglas. Here scattered patches and mousse and tar balls coalesced and seemed to reconstitute the spill in an area where many birds sleep on the water during the night. This resulted in a large numbers of oiled birds along the Katmai coast. An estimated 35% of the oil evaporated or dispersed into the water column, 40% affected the shorelines of islands inside of Prince William Sound. Perhaps 25% of the spill left the Sound as floating oil. (Doyle-PTT)
W91-08097

KINETICS OF BACTERIAL DEGRADATION OF BENZYLAMINE IN A MONTMORILLONITE SUSPENSION.
Cornell Univ., Ithaca, NY. Inst. for Comparative and Environmental Toxicology.
M. E. Miller, and M. Alexander.
Environmental Science and Technology ESTHAG, Vol. 25, No. 2, p 240-245, February 1991, 3 fig, 1 tab, 26 ref.

Descriptors: *Biodegradation, *Fate of pollutants, *Model studies, *Model testing, Adsorption, Aromatic hydrocarbons, Clay minerals, Isotherms, Kinetics, Mineralization, Montmorillonite, Organic pollutants, Soil contamination.

Reductions in the rate and extent of biodegradation have been attributed to sorption of organic compounds by constituents of soil and sediment which may reduce the availability of organic molecules to microorganisms. Information on the kinetics of

biodegradation is important in predicting the changes in concentration with respect to time and understanding how microorganisms transform organic compounds that are sorbed. A model to predict the biodegradation of sorbed organic chemicals by bacterial isolates was developed and tested on benzylamine sorbed in montmorillonite suspensions. The model requires inputs in the form of parameters provided by separate measurements of the adsorption isotherms under aseptic conditions and the rate of biodegradation in the absence of sorbent. Benzylamine mineralization was slower in the presence of montmorillonite, an expanding lattice clay with a great capacity for reversible binding of cations to its negatively charged magnesium-aluminosilicate sheets. Clay suspensions were thoroughly dispersed to provide the maximum number of exposed clay surfaces which adsorbed a considerable percentage of the benzylamine added. Experimental curves for the bacterial mineralization of benzylamine in well-dispersed suspensions were reproduced by the model with standard deviations of usually less than 4 percent. (Doyle-PTT)
W91-08098

COMPLETE ANALYSIS OF TECHNICAL CHLORDANE USING NEGATIVE IONIZATION MASS SPECTROMETRY.
Indiana Univ., Bloomington. School of Public and Environmental Affairs.
For primary bibliographic entry see Field 5A.
W91-08099

MECHANISMS OF INORGANIC PARTICLE FORMATION DURING SUSPENSION HEATING OF SIMULATED AQUEOUS WASTES.
Massachusetts Inst. of Tech., Cambridge. Dept. of Chemical Engineering.
For primary bibliographic entry see Field 5E.
W91-08100

DESORPTIVE BEHAVIOR OF TRICHLOROETHYLENE IN CONTAMINATED SOIL.
Clarkson Univ., Potsdam, NY. Dept. of Civil and Environmental Engineering.
S. G. Pavlostathis, and K. Jaglal.
Environmental Science and Technology ESTHAG, Vol. 25, No. 2, p 274-279, February 1991. 7 fig, 2 tab, 29 ref. New York State Center for Hazardous Waste Management (contract 150-W008A-R31346).

Descriptors: *Path of pollutants, *Trichloroethylene, *Soil contamination, *Adsorption, Chlorinated hydrocarbons, Fate of pollutants, Kinetics.

A two-phase pattern of desorption of organic chemicals from soils has been revealed by kinetic studies. An initial fast phase (in hours) followed by a slower phase (in days) has been observed. This biphasic desorption pattern is more pronounced in soils that were contaminated for longer time periods. An investigation of the desorptive behavior of trichloroethylene (TCE) in long-contaminated soil (silty clay) was conducted. Batch desorption of TCE reached steady state within 24 h. The temporal dependence of TCE desorption was reinforced in reequilibration studies, where a persistent fraction of TCE desorbed very slowly. The effect of pH was negligible and TCE desorption decreased with increases in ionic strength beyond 0.1M. Batch adsorption of TCE reached an apparent steady state in 3 days. The soil adsorption partition coefficient for TCE was estimated as 11.7 mL/g. Adsorption and desorption were not reversible over short equilibration times (on the order of days). With a short column, continuous TCE desorption showed an initial fast rate and a subsequent slower rate, revealing the high persistence of ppb levels of TCE in long-contaminated soil. An important implication of the slow release of TCE from long contaminated soils is its underestimation when aqueous soil suspensions are analyzed by the purge-and-trap method without any prior extraction. On the other hand, under natural field conditions low-permeability soils will effectively retain TCE, thus restricting its transport. (Doyle-PTT)
W91-08101

BROWN SNOW: A LONG-RANGE TRANSPORT EVENT IN THE CANADIAN ARCTIC.
Department of Fisheries and Oceans, Winnipeg (Manitoba). Freshwater Inst.
H. E. Welch, D. C. Muir, B. N. Billeck, W. L. Lockhart, and G. J. Brunskill.
Environmental Science and Technology ESTHAG, Vol. 25, No. 2, p 280-286, February 1991. 4 fig, 4 tab, 37 ref.

Descriptors: *Air circulation, *Air pollution, *Arctic regions, *Path of pollutants, *Sediment transport, *Snow, *Snow sampling, Canada, DDT, Insecticides, Organic compounds, Pollutant identification, Polychlorinated biphenyls, Polycyclic aromatic hydrocarbons, Sediment contamination.

The occurrence of a long-range transport event that deposited thousands of tons of fine particulates on the District of Keewatin, central Canadian Arctic, is documented. Air mass trajectories, clay mineral composition, soot particles, and visible organics point to Asian sources for the 'brown snow' material, probably western China. Semivolatile organic pollutants, detected in the brown snow included polycyclic aromatic hydrocarbons, (PAH), polychlorinated biphenyl (PCB) congeners, and DDT-related compounds, polychlorinated camphenes (PCCs), as well as the herbicide trifluralin and insecticides methoxychlor, endosulfan, and hexachlorocyclohexane (HCH)> Total PAH, PCB, and PCC concentrations were within the range reported in other studies of Arctic snow but total DDT levels were 2-10 times higher than previous reports. High molecular weight PAH may have been associated with soot particles in the brown snow, but evidence for Asian sources of the pesticides was not as strong because of unknown source signal strengths and possible atmospheric transformations of the compounds. Fluxes of these pollutants were also determined by analyzing sediment cores from two small headwater lakes near the sampling site. The quantities of pollutants deposited in this single event may have comprised a significant fraction (>10%) of total annual input of total PAH and total DDT, as determined from lake sedimentation records. (Author's abstract)
W91-08102

BIOSORPTION OF INORGANIC TIN AND METHYLTIN COMPOUNDS BY ESTUARINE MACROALGAE.
New Hampshire Univ., Durham. Dept. of Chemistry.
P. J. Wright, and J. H. Weber.
Environmental Science and Technology ESTHAG, Vol. 25, No. 2, p 287-294, February 1991, 7 fig, 2 tab, 37 ref. National Science Foundation Grant CES 86-12972.

Descriptors: *Algae, *Bioaccumulation, *Heavy metals, *Organotin compounds, *Path of pollutants, *Plant physiology, *Tin, Enteromorpha, Fucus, Kinetics, Sorption.

Biosorption kinetics of total recoverable inorganic tin (TRISn), MeSn (+++) Me2Sn ((++), and Me3Sn (+) compounds onto tissue from the macroalga Fucus vesiculosus and onto a mixed community of Enteromorpha spp. (a filamentous alga) showed that after 48-h accumulation of tin compounds, TRISn accumulation is approximately equal to MeSn (+++) and is greater than Me2Sn (++) which is greater than Me3Sn (+). Uptake of tin compounds onto F. vesiculosus consisted of three phases: rapid phase I, intermediate phase II (modeled by first-order kinetics), and slow phase III (modeled by zero-order kinetics). Uptake of tin compounds by Enteromorpha spp. occurred in rapid phase I and intermediate, saturating phase II, which was complete in 3 h for TRISn and MeSn (+++). After 24 h, TRISn and MeSn (+++) in dark-incubated F. vesiculosus were significantly less than in light incubated plants, suggesting active uptake processes during phase III. Enteromorpha spp. incubated in the dark for 1 h contained significantly less TRISn and MeSn (+++), but not less Me2Sn (++) and Me3Sn (+), than light incubated plants. Interactions with different compartments of algal thallus account for differences in amounts of biosorbed tin compounds. Initial phase I biosorption by both algae was probably adsorption onto the thallus surface. Phase II biosorption of TRISn and MeSn (+++) by Enteromorpha spp. involved an active process, which was probably into the cell protoplasm. In contrast, accumulation of tin compounds by F. vesiculosus during phase II was probably by cell wall matrix polysaccharides. Phase III accumulation of TRISn and MeSn (+++) by F. vesiculosus was also by an active process. (Author's abstract)
W91-08103

ISOTOPIC DISTRIBUTION OF CARBON FROM SEWAGE SLUDGE AND EUTROPHICATION IN THE SEDIMENTS AND FOOD WEB OF ESTUARINE ECOSYSTEMS.
Rhode Island Univ., Narragansett. Graduate School of Oceanography.
P. J. Gearing, J. N. Gearing, J. T. Maughan, and C. A. Oviatt.
Environmental Science and Technology ESTHAG, Vol. 25, No. 2, p 295-301, February 1991, 3 fig, 2 tab, 34 ref. National Oceanic and Atmospheric Administration Grant NA-83-ABD-00008.

Descriptors: *Distribution patterns, *Estuarine environment, *Eutrophication, *Food chains, *Isotopic tracers, *Organic carbon, *Path of pollutants, Carbon radioisotopes, Sediments, Sludge, Sludge disposal.

Although studies show sewage sludge to be a relatively poor energy source, it has often been hypothesized that opportunistic marine organisms use sludge as a food supplement in disposal areas. However, quantitative data to support this hypothesis are lacking. Stable isotope ratios (sigma C-13) from samples of water, sediments, and biota traced the behavior of organic carbon for 3 summer months in estuarine mesocosms (three controls, three with added sewage sludge, three with added inorganic nutrients). Isotope ratios proved to be a useful quantitative tracer for sewage carbon as well as for the fresh phytoplanktonic carbon produced during nutrient fertilization. Sewage sludge sedimented within hours of its addition, and approximately 50% remained in sediments after 99 days. The sludge was not inert, but was biologically oxidized at rates similar to those of phytoplankton carbon. Its residence time in the water column was too short for uptake by zooplankton, but it was readily assimilated by some benthic organisms. Fresh phytoplanktonic carbon from nutrient-induced blooms was isotopically heavy and thus distinguishable from old primary production (fixed before the experiment). It flowed through the pelagic and benthic food webs more extensively and more uniformly than did sludge carbon. Carbon isotopes proved to be quite useful for tracing eutrophication, since even under non-ideal conditions carbon isotope ratios were able to trace sludge carbon with greater than 90% statistical significance. (Doyle-PTT)
W91-08104

RARE EARTH ELEMENTS IN SEDIMENTS OFF SOUTHERN CALIFORNIA: A NEW ANTHROPOGENIC INDICATOR.
Massachusetts Inst. of Tech., Cambridge. Nuclear Reactor Lab.
I. Olmez, E. R. Sholkovitz, D. Hermann, and R. P. Eganhouse.
Environmental Science and Technology ESTHAG, Vol. 25, No. 2, p 310-316, February 1991. 5 fig, 5 tab, 31 ref. U.S. Department of Energy Grant DE-FG-2-80ER10770.

Descriptors: *California, *Chemical tracers, *Pollutant identification, *Rare earth elements, *Sediment contamination, *Water pollution sources, Catalysts, Continental shelf, Cores, Marine sediments, Oil refineries.

The rare earth elements (REE) composition of sediment cores from the San Pedro Shelf (60 m) and the Santa Barbara Basin (588 m) off the California coast are contrasted. The Santa Barbara Basin core has relatively uniform REE concentrations throughout its 60-cm length and a REE composition similar to the crustal abundance. In con-

trast, the upper 20 cm of the 36-cm San Pedro Shelf core collected in 1981 is enriched in the light REE (La, Ce, Nd, Sm) but not the middle REE (Eu) or the heavy REE (Yb, Lu). These upper sediments and two effluent particulate samples obtained in 1979 have REE signatures markedly different from crustal material. This is a result of anthropogenic inputs beginning in the early 1960s from the Joint Water Pollution Control Plant wastewater outfall 6 km up-current from the San Pedro Shelf core. The sources of the light REE enrichment are petroleum-cracking catalysts and their products; these include bottom ash, fly ash, and wastewater from oil-fired power plants and oil refineries. Cracking catalysts, which are produced primarily from two REE materials, bastnasite and monazite, are strongly enriched in light REE. With their unique signature and source, the REE may be a new tracer for anthropogenic inputs in coastal environments. (Author's abstract)
W91-08105

TRANSPORT OF DISSOLVED ORGANIC MACROMOLECULES AND THEIR EFFECT ON THE TRANSPORT OF PHENANTHRENE IN POROUS MEDIA.
Cornell Univ., Ithaca, NY.
B. R. Magee, L. W. Lion, and A. T. Lemley.
Environmental Science and Technology ESTHAG, Vol. 25, No. 2, p 323-331, February 1991. 9 fig, 3 tab, 42 ref, append.

Descriptors: *Groundwater pollution, *Path of pollutants, *Phenanthrene, *Polycyclic aromatic hydrocarbons, Dispersion, Dissolved organic matter, Distribution patterns, Model studies, Organic pollutants, Soil contamination.

Since hydrophobic contaminants tend to sorb strongly to porous media, the risk to water users distant from the contaminant source is assumed to be low. However, dissolved macromolecules dispersed in the groundwater may sorb these pollutants allowing them to be transported with these mobil carriers. The phenomenon of facilitated transport may explain the failure of some environmental fate models to accurately predict contaminant migration based on calculations of sorptive partitioning. The retardation factor (R) of phenanthrene in a sand column was reduced by an average factor of 1.8 in the presence of dissolved organic matter (DOM) derived from soil, suggesting that a phenanthrene-DOM complex enhanced the transport of phenanthrene. Distribution coefficients were determined in batch and column studies for combinations of phenanthrene and DOM with sand. The retardation factor in the advective-dispersive transport equation was modified to reflect the presence of a carrier by incorporating both the retardation and pore exclusion of the carrier itself. The best prediction of phenanthrene transport in the presence of DOM was provided by modeling the retardation by using two distribution coefficients derived from column experiments of DOM alone and phenanthrene alone, along with the distribution coefficient for phenanthrene binding to DOM. Sensitivity analyses indicated that the critical model parameters are the distribution coefficients for the hydrophobic pollutant binding to the stationary phase and binding to the carrier, as well as the carrier concentration. (Doyle-PTT)
W91-08106

METEOROLOGICAL CONDITIONS THAT KEPT LONG ISLAND AND NEW JERSEY BEACHES FREE OF FLOATABLES DURING THE SUMMER OF 1989.
State Univ. of New York at Stony Brook.
R. L. Swanson, and A. Valle-Levinson.
Journal of Environmental Systems JEVSBH, Vol. 20, No. 1, p 53-69, 1990/1. 11 fig, 4 ref.

Descriptors: *Detritus, *Flotsam, *Long Island Sound, *New Jersey, *New York Bight, Climate changes, Coastal waters, Estuaries, Excess rainfall, Temperature effects, Wind velocity.

During the summer of 1989, the coasts of Long Island and New Jersey were relatively free of floatable debris washing ashore on their beaches as compared to the previous two summers. The extensive rainfall recorded in this period (twice as much as the normal amount) must have contributed floatable wastes to the New York Bight; however, the wind characteristics (speed, direction, constancy, and energy) were such that they distributed the floatables offshore and away from the coasts of Long Island and New Jersey. When compared to the climatology of the summers of 1987 and 1988, it is found that the summer of 1989 was unusual in relation to its high precipitation (567 mm), its low wind constancy (19-21%), and its lower air mean temperatures (1 C lower than normal). These conditions are not those generally associated with major floatable problems. Consequently, the floatable collection program implemented in the New York/New Jersey Harbor Estuary did not get a rigorous test with regard to keeping area beaches open. (Author's abstract)
W91-08112

MERCURY CONCENTRATION IN FISH FROM SMITH MOUNTAIN LAKE.
Ferrum Coll., VA. Life Science Div.
A. P. Corkum, and D. M. Johnson.
Virginia Journal of Science VJSCAI, Vol. 41, No. 4B, p 473-477, Winter 1990. 3 fig, 1 tab, 7 ref.

Descriptors: *Bioaccumulation, *Fish, *Heavy metals, *Mercury, *Path of pollutants, *Virginia, Atomic absorption spectroscopy, Bass, Catfish, Fish pathology, Histology, Smith Mountain Lake.

Mercury is a naturally occurring element that is widely but unevenly distributed throughout the environment, and low concentrations are present in unpolluted waters. Because mercury is a cumulative poison, its concentration in fish tissues is indicative of mercury levels in the water. Mercury levels were determined in fish taken from Smith Mountain Lake, a 20,000 acre pump-storage reservoir in southwestern Virginia. Striped bass, largemouth bass, and channel catfish were collected during 1987 and 1988 by personnel from Ferrum College and the Virginia Commission of Game and Inland Fisheries. A total of 51 fish were analyzed for mercury at Ferrum College. Tissue samples were digested with nitric acid and hydrogen peroxide to convert various forms of mercury to the divalent cation. Mercury was determined by atomic absorption spectroscopy using the cold vapor technique. The overall mean mercury concentration was 50 ppb, five percent of the FDA standard of 1 ppm (1000 ppb). When grouped by species, the bass had significantly higher tissue concentrations of mercury than the catfish. Mean concentrations were 58 ppb and 29 ppb, respectively. At these levels, consumption of fish from Smith Mountain Lake is not a concern with respect to dietary intake of mercury. The fish were also sorted by weight and a significant correlation between weight and tissue concentration of mercury was observed in both species of bass but not for catfish. This was expected because bass, as predators, are higher on the food chain than catfish which are primarily scavengers. (Doyle-PTT)
W91-08113

MOBILIZATION OF HEAVY METALS FROM RIVER SEDIMENTS OF NORTHERN GREECE BY COMPLEXING AGENTS.
Thessaloniki Univ., Salonika (Greece). Lab. of Analytical Chemistry.
V. Samanidou, and K. Fytianos.
Water, Air and Soil Pollution WAPLAC, Vol. 52, No. 3/4, p 217-225, 1990, 6 fig, 3 tab, 20 ref.

Descriptors: *Chelating agents, *Complexing agents, *Greece, *Heavy metals, *Path of pollutants, *River sediments, *Sediment-water interfaces, *Trace elements, Cadmium, Chromium, Copper, Detergents, Distribution patterns, EDTA, Lead, Manganese, Nitrilotriacetate, Sediment contamination, Water pollution sources.

The growing use of synthetic complexing agents in detergents in order to replace polyphosphates potentially results in mobilization of heavy metals from aquatic sediments. The influence of synthetic complexing agents; NTA, EDTA, STPP, Triton X100, and inorganic complexing agents, PO4(---) and NO3 (-), on the mobilization of Pb, Cd, Cu, Cr, and Mn from sediments of the Axios and Aliakmon rivers located in Northern Greece was studied. The release caused by all examined complexing agents was higher in deionized water than in either Axios or Aliakmon river water due to the lack of competition of Ca and Mg cations with the heavy metals for the studied complexing agents, and the decrease of ionic strength. From all examined agents NTA and EDTA showed the greater mobilization ability. Copper showed the greatest tendency for remobilization by all examined agents, according to the order: EDTA and NTA are greater than Triton X100, and PO4(---) which are greater than NO3(-) and STPP. Cr and Mn had the smallest tendency following the orders for Cr: NTA and PO4(---) are much greater than NO3(-), Triton x100, EDTA, and STPP, while for Mn the order was; STPP is greater than EDTA which is greater than NTA which is greater than Triton X100, PO4(---) and NO3(-). An increase in mobilization was also noticed with an increase of agent concentration and time of shaking. (Doyle-PTT)
W91-08114

CONTRIBUTION OF SULFATE TO RAINFALL PH AROUND KILAUEA VOLCANO, HAWAII.
Hawaii Univ. at Manoa, Honolulu. Dept. of Environmental Health Sciences.
B. Z. Siegal, M. Nachbar-Hapai, and S. M. Siegal.
Water, Air and Soil Pollution WAPLAC, Vol. 52, No. 3/4, p 227-235, 1990. 1 fig, 6 tab, 17 ref.

Descriptors: *Acid rain, *Hawaii, *Sulfates, *Sulfur dioxide, *Volcanoes, Air pollution sources, Distribution patterns, Hydrogen ion concentration, Kilauea.

Between December 1986 and June 1987, the mean pH of rainfall downwind of the Kilauea main vent was found to be 4.5 (range 4.0 to 5.6), 1.2 units higher than the year before (1985-86), although 84% of the 12 sequential samples fell below pH 5.0. The SO4 content, however, was 34% higher, averaging 18.5 mg/L. Upwind, in open forest the mean pH 4.7 was little changed from that measured before. Mean SO4, however, has fallen to a low of 2.5 mg/L, but, more significantly, in 9 out of 12 sequential samples SO4 was not detectable at all (i.e. < 0.5 mg/L). The concentrations contributed by deposited SO2, if assumed to be 100% H2SO4, by calculation, cannot account for a pH lower than 5.3, yet 58% of these samples fell below pH 5.0, the lowest being 4.0. Disparities between pH measured and calculated on the basis of SO4 content indicated that other acid species were present in the precipitation. Hydrogen peroxide was added to rain samples to oxidize deposited SO2 and this greatly increased SO4 content and lowered pH in downwind samples, but failed in most cases to alter either parameter in the upwind collections. These observations, together with the elimination of HCl and NO3 by others, suggested that SO2 contributes significantly to acidity downwind, but that in upwind samples a source of H(+) other than mineral acids, presumably organic compounds such as formic acid, must be of major importance. A signature compound and the specific nature of acidic components in Hawaiian precipitation, over remote forested areas, remains to be determined. (Doyle-PTT)
W91-08115

DISTRIBUTION OF NITROGEN SPECIES IN POLLUTED ONONDAGA LAKE, N.Y., U.S.A.
Upstate Freshwater Inst., Inc., Syracuse, NY.
C. M. Brooks, and S. W. Effler.
Water, Air and Soil Pollution WAPLAC, Vol. 52, No. 3/4, p 247-262, 1990. 4 fig, 3 tab, 38 ref.

Descriptors: *Distribution patterns, *Eutrophic lakes, *Lakes, *Limnology, *New York, *Nitrogen cycle, *Path of pollutants, Algae blooms, Ammonia, Anoxic conditions, Lake Onomdaga, Lake stratification, Nitrates, Nitrites, Nitrogen compounds, Seasonal variation, Water pollution effects.

Various forms of nitrogen have important water quality implications for lakes. Some are important plant nutrients, others are significant sinks for dis-

solved oxygen, and still others are toxic to fish in rather low concentrations. The seasonality of temporal and vertical distributions of four N species, NO3 (-), NO2 (-), total ammonia (T-NH3), and free ammonia (NH3), is documented for the spring to fall interval of a single year in Onondaga Lake, an urban, polluted, hypereutrophic, dimictic, lake that receives a very high load of T-NH3 from an adjoining metropolitan sewage treatment plant. Concentrations of all measured forms were uniform with depth during the spring and fall turnovers, however, pronounced variations were observed during the period of stratification. Nitrate and NO2 (-) were lost rapidly from the hypolimnion, and T-NH3 accumulated to high concentrations (maximum > 10 mg/L), after the onset of anoxia in early June, consistent with the lake's high level of productivity. The concentrations T-NH3, NH3 and NO3 (-) that were maintained in the epilimnion (average concentrations at a depth of 1 m of 2.81, 0.16, and 0.91 mg N/L respectively), were high in comparison to levels reported in the literature. These elevated concentrations are largely a result of the extremely high loads of T-NH3, and its precursors, received by the lake. Water quality problems in the lake related to the prevailing high concentrations of N species include potential toxicity effects and severe lake-wide oxygen depletion during the fall turnover. (Doyle-PTT)
W91-08117

FATES OF RADIOTRACERS ADDED TO A WHOLE LAKE: ACCUMULATION IN FATHEAD MINNOW (PIMEPHALES PROMELAS) AND LAKE TROUT (SALVELINUS NAMAYCUSH).
Department of Fisheries and Oceans, Winnipeg (Manitoba). Freshwater Inst.
S. E. Harrison, J. F. Klaverkamp, and R. H. Hesslein.
Water, Air and Soil Pollution WAPLAC, Vol. 52, No. 3/4, p 277-293, 1990. 5 fig, 2 tab, 32 ref.

Descriptors: *Bioaccumulation, *Chemical tracers, *Fathead minnows, *Fish, *Heavy metals, *Lakes, *Ontario, *Path of pollutants, *Radiochemical analysis, *Radioisotopes, *Trout, Canada, Distribution patterns, Eutrophic lakes, Histology, Oligotrophic lakes, Tissue analysis, Trace elements.

Six gamma-emitting isotopes, Se-75, Hg-203, Cs-134, Fe-59, Zn-65 and Co-60, were introduced simultaneously in a single epilimnetic addition to an oligotrophic lake on the Precambrian Shield of northwestern Ontario, Canada. Accumulation of each isotope was monitored on fathead minnow (Pimephales promelas) for 274 days. Isotope accumulation in blood, gill, gut, liver, kidney, spleen, gonad, brain, muscle and gut contents of lake trout (Salvelinus namaycush) was monitored for 352 days. Fish accumulated only traces of Fe-59. Isotopes which occurred in water primarily in the charcoal-extracted fraction (Se-75 and Zn-65) were most readily accumulated by fish. Fathead minnow accumulated higher concentrations of all isotopes than lake trout. In lake trout, the highest concentrations of isotopes were found in the following tissues: Se-75, liver; Hg-203 and Co-60, kidney; Cs-134, muscle; Zn-65, gut. Food seemed to be the primary source of all isotopes to fish. Ratios of isotope concentrations in fish to those in water were higher for both fathead minnow and lake trout than ratios reported from laboratory studies using aqueous exposures. Concentration ratios for Cs-134 in both fathead minnow and lake trout from oligotrophic Lake 224 were over an order of magnitude greater than published data for fish from eutrophic lakes. (Author's abstract)
W91-08119

WET DEPOSITION TRENDS OF MAJOR INORGANIC IONS IN FINLAND BASED ON DAILY BULK DEPOSITION SAMPLES.
Finnish Meteorological Inst., Helsinki. Air Quality Dept.
T. Laurila.
Water, Air and Soil Pollution WAPLAC, Vol. 52, No. 3/4, p 295-324, 1990. 11 fig, 26 ref.

Descriptors: *Acid rain, *Atmospheric chemistry, *Finland, *Path of pollutants, Ammonium, Calcium, Chemistry of precipitation, Distribution patterns, Europe, Hydrogen ion concentration, Magnesium, Nitrates, Rainfall, Sulfates.

Trends in the precipitation-weighted average concentrations and in the deposition of inorganic ions in daily precipitation samples at three Finnish background stations were calculated for a period extending from the seventies to 1988. During the period 1973-1988, SO4(--) concentrations in wet deposition at the station in Central Finland decreased by 39% in accordance with the emission decrease of SO2 in Finland of 50% over the same period, and the 20% decrease in Europe from 1980 to 1988. However, due to more significant decreases in alkaline ions (80% for Mg(++), H(+) concentrations increased by 30%. At the two southernmost stations, overall concentrations are higher and the decrease of Mg(++) and Ca(++) is less important, but at the station in southeastern Finland the increase of NO3 (-) relative to NH4(+) has doubled H(+) concentrations during the period 1977-1988. Division of the data according to wind direction sectors showed generally decreasing concentrations in the sectors related to Scandinavia, but unchanging or increasing concentrations in the sectors related to eastern Europe. Acid deposition trends were estimated as H(+), SO4(--) -(Ca+Mg (++)), and H(+)(+)NH4(+)-NO3(-). All these trends showed increasing acid deposition in central Finland and decreasing trends in western Finland. In eastern Finland the trends were opposing due to the increasing NO3 but decreasing NH4+ trends. It is concluded that SO4(--) deposition trends do not reflect acid deposition trends, and SO4(--) or NO3(-) deposition do not geographically represent acid deposition. (Author's abstract)
W91-08120

FATE OF C14-CARBARYL IN SOILS AS A FUNCTION OF PH.
Bhabha Atomic Research Centre, Bombay (India). Nuclear Agriculture Div.
N. B. K. Murthy, and K. Raghu.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 46, No. 3, p 374-379, March 1991. 4 tab, 13 ref.

Descriptors: *Carbaryl, *Fate of pollutants, *Path of pollutants, *Pesticide residues, *Soil contamination, Carbamate pesticides, Carbon radioisotopes, Clay soils, Degradation products, Hydrogen ion concentration, Loam, Metabolites, Naphthalenes, Sandy soils, Soil environment, Soil properties, Thin layer chromatography.

The fate of the broad-spectrum insecticide carbaryl was studied in the soil environment as a function of pH with respect to the formation of extractable and non-extractable (soil bound) residues. Soil samples (sandy clay, sandy loam, and clay) containing 10 ppm C14-carbaryl were incubated at 28 to 30 C for periods ranging from 7 to 56 days. The extractable C14-residues were more in sandy clay and sandy loam than in clay soil both under moist and flooded conditions. In general, flooding had no influence on the extractable C14-residues. Thin-layer chromatography of chloroform extracts revealed the presence of carbaryl and its metabolite, 1-naphthol. At the end of 56 days, the % carbaryl recovered was 32.1, 6.4, and 1.0 in sandy clay, sandy loam and clay soils, respectively. There appeared to be a correlation between soil pH and soil bound residues formation as an increase in soil pH was reflected in increased bound residues. The humin portion of soil organic matter accounted for most of the C14-bound residues. Comparison of C14-mass balance in the three soils showed better recovery in clay soil than in the other two soils. Low recoveries in sandy clay and sandy loam soils may stem from possible mineralization of carbaryl. An increase in soil pH decreased extractable carbaryl residues and increase soil bound residues. (VerNooy-PTT)
W91-08162

CU AND ZN UPTAKE BY HALIMIONE PORTULACOIDES (L.) AELLEN: A LONG TERM ACCUMULATION EXPERIMENT.
Universidade Nova de Lisboa (Portugal).
For primary bibliographic entry see Field 5C.
W91-08163

CHEMICAL SPECIATION AND BIOAVAILABILITY OF CU(II): STUDY OF THE IONIC COPPER(II) AND BIS(GLYCINATE)-COPPER(II) ACCUMULATION BY LEMNA SPECIES.
Ceskoslovenska Akademie Ved, Ceske Budejovice. Inst. of Landscape Ecology.
For primary bibliographic entry see Field 5C.
W91-08166

EFFECT OF STARVATION ON TRACE METAL LEVELS IN BLUE MUSSELS (MYTILUS EDULIS).
Department of Fisheries and Oceans, Halifax (Nova Scotia). Physical and Chemical Sciences Branch.
For primary bibliographic entry see Field 5A.
W91-08167

METHANE FLUXES IN THE SOUTHERN NORTH SEA: THE ROLE OF EUROPEAN RIVERS.
State Univ. of New York at Stony Brook. Marine Sciences Research Center.
M. I. Scranton, and K. McShane.
Continental Shelf Research CSHRDZ, Vol. 11, No. 1, p 37-52, January 1991. 3 fig, 3 tab, 51 ref. ONR Contract N00014-88-K-0448.

Descriptors: *Air pollution sources, *Marine pollution, *Methane, *North Sea, *Path of pollutants, *Pollution load, *Stream pollution, Aquatic bacteria, Chemical analysis, Coastal waters, Gases, River mouth, Spatial distribution.

One aspect of the global methane cycle which remains poorly understood is the role of oceans and rivers as sources of methane to the atmosphere. Methane distributions were measured in the Southern Bight of the North Sea during March 1989 as part of the North Sea Program of the United Kingdom Natural Environment Research Council. Methane concentrations in the open North Sea were at or near solubility equilibrium with the atmosphere, but near the coast of the Netherlands, in the plume of the Rhine, extremely high methane values (as high as 120 times saturation) were observed. Both the Rhine and Scheldt rivers, and possibly coastal sediments, seemed to be significant regional sources of methane. Methane oxidation represented a relatively small sink for methane in the North Sea compared to gas loss to the atmosphere. This was due, in part, to the fact that methane oxidizing bacteria within the river plume appeared to be oxidizing the gas at close to their maximal rate, although offshore bacteria were able to increase oxidation rates as methane concentrations increased. Thus, these studies suggested that bacterial methane oxidation kinetics were saturated at much lower methane concentrations in plume or estuarine waters than in open situations. If the Rhine and Scheldt are the sources of the methane found in the Southern Bight, river concentrations of methane must be high (order of 50 to 500 nM). Although rivers and coastal zones may not represent a major atmospheric source of methane, they can be very important as methane sources to the coastal ocean. (Author's abstract)
W91-08169

FACTORS DETERMINING THE UPTAKE OF PERSISTENT POLLUTANTS IN AN EEL POPULATION (ANGUILLA ANGUILLA L).
Lund Univ. (Sweden). Limnological Inst.
P. Larsson, S. Hamrin, and L. Okla.
Environmental Pollution ENPOEK, Vol. 69, No. 1, p 39-50, 1991. 3 fig, 38 ref.

Descriptors: *Bioaccumulation, *Eel, *Eutrophic lakes, *Lindane, *Path of pollutants, *Polychlorinated biphenyls, *Water pollution effects, DDD, DDE, DDT, Distribution, Growth rates, Lake fisheries, Life cycles, Pollutant identification, Scandinavia.

The distribution of persistent pollutants in an eel population from a eutrophic lake of southern Scandinavia was examined. Eels (Anguilla anguilla) in their freshwater phase (yellow eel) were captured by trawling in the summer of 1988. Twenty-five polychlorinated (PCB) congeners, p,p-DDT, p,p-DDE, p,p-DDD and lindane were always detected in the eels. Concentrations of total PCBs ranged from 209 to 6582 ng/g extractable fat (22 to 1071 ng/g fresh weight). The origin of PCBs, DDT, DDE and lindane found in the fish was most likely the atmosphere. The most important factors for uptake of the chlorinated hydrocarbons was age (exposure time), growth rate and fat content. The life cycle of the eel is unique with a stage in freshwater when energy reserves (fat stored in muscular tissue) and lipophilic pollutants are accumulated. This stage is followed by a long migration to the spawning areas in the Sargasso Sea when pollutants are released from the fat deposits. These two stages, followed by an once-in-a-lifetime spawning behavior, makes the eel especially vulnerable to persistent pollutants. The effects of persistent pollutants combined with the eel's unusual life cycle may explain the decline in the eel population in northern Europe in recent decades. (Author's abstract)
W91-08172

HEXAGENIA RIGIDA (EPHEMEROPTERA) AS A BIOLOGICAL MODEL IN AQUATIC ECOTOXICOLOGY: EXPERIMENTAL STUDIES ON MERCURY TRANSFERS FROM SEDIMENT.
Bordeaux-1 Univ., Talence (France). Lab. d'Ecologie Fondamentale et d'Ecotoxicologie.
E. Saouter, F. Ribeyre, A. Boudou, and R. Maury-Brachet.
Environmental Pollution ENPOEK, Vol. 69, No. 1, p 51-67, 1991. 3 fig, 28 ref.

Descriptors: *Bioaccumulation, *Mayflies, *Mercury, *Organomercury compounds, *Path of pollutants, *Sediment contamination, Animal tissues, Aquatic insects, Correlation analysis, Foods, Model studies.

The accumulation of two mercury compounds--mercury dichloride (HgCl2) and methylmercury chloride (CH3HgCl)--by Hexagenia rigida (burrowing mayfly nymphs) from contaminated sediments was investigated experimentally. Three exposure periods were selected: 7, 14, and 28 days. Results revealed a high capacity of this species for Hg accumulation and considerable differences between the two chemical forms of the metal. Thus, the amount of total mercury accumulated after 28 days' exposure would be 60 times greater for the organic form if the two compounds were initially added to the sediment in the same concentrations. No significant growth inhibition appears for the different experimental conditions studied. Data treatment at the organism level showed a positive linear correlation between the fresh weight and Hg content in the nymphs; this was especially marked when the exposure time was relatively long and Hg was in the form of CH3HgCl. The study of mercury distribution in the organs of Hexagenia rigida (gills and gut) and examination of the nymphs via the water column showed the importance of the trophic route, via ingested sediment, for bioaccumulation of metal initially introduced into the sediment. (Author's abstract)
W91-08173

RADON CONCENTRATIONS IN GROUND WATER OF THE GEORGIA PIEDMONT.
Georgia Inst. of Tech., Atlanta. School of Earth and Atmospheric Sciences.
M. E. Dillon, G. L. Carter, R. Arora, and B. Kahn.
Health Physics HLTPAO, Vol. 60, No. 2, p 229-236, February 1991. 5 fig, 5 tab, 15 ref.

Descriptors: *Geohydrology, *Georgia Piedmont, *Groundwater pollution, *Path of pollutants, *Radon radioisotopes, *Well data, Air pollution sources, Data collections, Geohydrologic units, Granites, Water pollution sources.

Radon-222 concentrations in 283 wells, mostly private, drilled into crystalline bedrock in the Piedmont region east of Atlanta, GA had a geometric mean value of 110 Bq/L. The values generally were lognormally distributed, with a geometric standard deviation of 4.0. Forty-two samples exceeded 400 Bq/L. Mean radon (Rn) concentrations were related to hydrogeologic units. The geometric mean concentration was 230 Bq/L for a muscovite-biotite granite gneiss that includes Lithonia gneiss, 100 Bq/L for amphibolite interlayered with muscovite-biotite schist, and about 50 Bq/L for all others. The wells tested generally had low yields. No correlations of Rn concentrations were found with well depth, distance of well though saprolite, or well yield. No geographic pattern or source of the highest Rn concentrations was apparent. The wells with the highest Rn222 concentrations all were in valleys or hillsides. Observed concentrations are considerably higher than averages found for large public well supplies in the US but are similar to levels found for smaller supplies throughout the Appalachian Piedmont. In view of the estimate that Rn222 at 400 Bq/L in water could lead to 0.15 Bq/L in air, it appears desirable to monitor homes supplied with well water in certain areas of this region to assure that indoor Rn222 air levels conform with federal and state recommendations. (VerNooy-PTT)
W91-08176

WATER QUALITY OF THE WEST BRANCH LACKAWAXEN RIVER AND LIMNOLOGY OF PROMPTON LAKE, WAYNE COUNTY, PENNSYLVANIA, OCTOBER 1986 THROUGH SEPTEMBER 1987.
Geological Survey, Harrisburg, PA. Water Resources Div.
J. L. Barker.
Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4014, 1989. 28p, 9 fig, 10 tab, 8 ref.

Descriptors: *Eutrophication, *Lackawaxen River, *Pennsylvania, *Prompton Lake, *Water quality, Ammonia, Chlorophyll, Limnology, Nitrites, Nitrogen, Seasonal variation, Suspended sediments.

Past and present water quality of the West Branch Lackawaxen River and Prompton Lake generally meet the State of Pennsylvania standards for high quality waters that support the maintenance and propagation of cold water fishes. However, suggested criteria by the US EPA intended to control excessive algal growth in the lake are exceeded most, if not all, of the time for nitrogen and most of the time for phosphorous. The average annual nitrogen load entering the lake is 114 tons. Of this total, 41 tons is inorganic nitrite plus nitrate, 48 tons organic nitrogen, and 25 tons ammonia nitrogen. Estimated annual yields of total nitrogen, inorganic nitrite plus nitrate, organic nitrogen, and ammonia nitrogen are 1.9, 0.7, 0.8, and 0.4 tons/sq mi, respectively. The average annual phosphorous load is estimated to be 4.7 tons, which is equivalent to a yield of 0.08 tons/sq mi. About 62%, or 2.9 tons, is dissolved phosphorous that is readily available for plant assimilation. The waters of the West Branch Lackawaxen River and Prompton Lake are decidedly phosphorous limited. The long-term average annual suspended-sediment yield to the lake is about 70 tons/sq mi. Life expectancy of the 774 acre-ft of space allocated for sediment loads in the raised pool is estimated to be about 287 years. Lake profile studies show that thermal and chemical stratification develops in early June and persists through September. Water below a depth of about 20 feet becomes anoxic, or nearly so, by mid-July. (Lantz-PTT)
W91-08184

SOURCE IDENTIFICATION, TESTING, AND TREATMENT.
Eckenfelder, Inc., Nashville, TN.
P. W. Lankford.
IN: Toxicity Reduction in Industrial Effluents. Van Nostrand Reinhold, New York. 1990. p 60-97, 14 fig, 13 tab, 12 ref.

Descriptors: *Industrial wastewater, *Laboratory methods, *Pretreatment of wastewater, *Wastewater treatment, *Water pollution control, *Water pollution sources, *Water pollution treatment, Biodegradation, Biological treatment, Effluent streams, Effluents.

A source survey of an industrial plant can be an extremely valuable and powerful tool in incorporating source testing and treatment into an overall toxicity reduction effort. The intent and objective of the survey is to identify potentially toxic materials in the effluent, identify the source(s) of these materials, and consider alternative means of dealing with them. There are many alternative ways of performing such a survey and the engineers most familiar with an industry or process will be the best suited to establishing and executing a plan. However, one logical and practical approach has been developed which includes the essential ingredients of an industrial toxicity survey, the materials inventory, examination of relevant literature, and the comparison of the effluent with a raw materials inventory. Once the sources of principal concern are identified, treatment characteristics for each source are evaluated with respect to the existing end-of-pipe treatment technology at the facility, typically biological treatment such as activated sludge. Each source discharge should be defined as to biological treatability so as to take maximum advantage of the existing effluent treatment system. Following this determination, methods for reducing or eliminating source contributions through source treatment should be specifically addressed. This effort lends itself to presentation as a methodology which proceeds stepwise through the testing effort necessary to define the disposition of a given source. The alternatives are: inclusion in the total waste stream without pretreatment; inclusion in the total waste stream after pretreatment; and recovery, recycle, substitution, or elimination. Source treatment requirements can include any of the following, depending on the nature of the source: pretreatment to remove a bioinhibitor or biotoxicant; pretreatment to improve biodegradation rate or amount; removal of contaminants in order to discharge; and treatment for recovery, recycle, substitution, or elimination. Where possible, process modification should be evaluated initially as the preferred solution. After process modification is considered, the second effort should consist of conducting treatment tests on the identified sources. (See also W91-08191) (Lantz-PTT)
W91-08195

5C. Effects Of Pollution

EFFECTS OF LONG-TERM PHENOXYALKANOIC ACID HERBICIDE FIELD APPLICATIONS ON THE RATE OF MICROBIAL DEGRADATION.
Agriculture Canada, Regina (Saskatchewan). Research Station.
A. E. Smith, and G. P. Lafond.
IN: Enhanced Biodegradation of Pesticides in the Environment. ACS Symposium Series 426. American Chemical Society, Washington, DC. 1990. p 14-22. 2 tab, 40 ref.

Descriptors: *Biodegradation, *Fate of pollutants, *Microbial degradation, *Microorganisms, *Pesticides, *Soil contamination, *Soil environment, Adaptation, Agricultural chemicals, Field tests, Herbicides, Literature review, Metabolism, Phenoxy acid herbicides, Soil bacteria.

Studies of factors influencing the breakdown of the herbicides 2,4-dichlorophenoxyacetic acid (2,4-D) and 4-chloro-2-methlyphenoxyacetic acid (MCPA) in soil were reviewed. Studies indicated that abiotic processes do not appear to result in any significant degradation of phenoxyalkanoic acids in the soil. The importance of soil microorganisms for the degradation of 2,4-D and MCPA was demonstrated by soil perfusion experiments. It has been concluded that degradation rate in soil is probably dependent upon herbicide concentration, with the breakdown approximating first-order kinetics at soil concentrations below about 5 ppm, while at increased herbicide concentrations biphasic breakdown occurs. Soil temperature above 10 C and moistures above the wilting point are required for biodegradation of phenoxyalkanoic acids. Results indicated that repeated treatments of 2,4-D and

MCPA resulted in enhanced herbicide degradation rates under field conditions as a result of adaptation of soil microorganisms. There is also some evidence that cross-enhancement can occur under field conditions, whereby previous applications of either 2,4-D or MCPA result in enhanced breakdown of both herbicides. Enhanced degradation has the environmental advantage of reducing the residence time of the herbicides in soil and thus lessening the possibility of chemical movement by leaching and run-off. (See also W91-07118) (MacKeen-PTT)
W91-07120

ECOLOGICAL EXPOSURE/RISK ASSESSMENT OF HAZARDOUS WASTES.
Environmental Protection Agency, Washington, DC. Office of Environmental Processes and Effects Research.
For primary bibliographic entry see Field 5G.
W91-07173

DETERMINATION OF THE CHEMICAL SUITABILITY OF A DREDGED MATERIAL CONTAINMENT AREA FOR AQUACULTURE.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
H. E. Tatem.
Available from the National Technical Information Service, Springfield, VA 22161. Technical Report EL-90-12, December 1990. Final Report. 75 p, 2 fig, 7 tab, 54 ref, 4 append.

Descriptors: *Aquaculture, *Dredging wastes, *Reuse, *Waste containment, *Water pollution effects, Bioassay, Cadmium, Chemical analysis, Chlorinated hydrocarbons, Lead, Mercury, Metals, Shrimp, Site selection.

An investigation was conducted into the use of dredged material containment areas (DMCA) for aquaculture, specifically for production of a crop intended for human consumption. Most dredged material is uncontaminated and many sediment constituents such as metals are relatively unavailable to aquatic animals. DMCAs containing parts/million levels of organic contaminants such as pesticides, polychlorinated biphenyls, or petroleum hydrocarbons should not be used for aquaculture without extensive testing. Common sediment contaminants are ranked according to their potential for harm to the biota. Hg, Cd, Pb, and certain chlorinated hydrocarbons were identified as potentially harmful at high concentrations. Chemical and biological testing of sediment from an aquaculture demonstration site at Brownsville, TX, showed that this DMCA was acceptable for aquaculture since the sediment contained a high percentage of sand and low (compared with reference materials) concentration of contaminants. Organic contaminants were below detection limits. Bioassay results showed that DMCA sediments were not toxic to a test animal (Mysidopsis sp.) or to a proposed aquaculture animal, a penaeid shrimp. Both recent chemical data and bioassay testing of actual DMCA sediments are necessary before a potential DMCA site can be recommended for aquaculture. A table of US Food and Drug Administration (USFDA) action levels for contaminants in seafood is included. An aquaculture crop should be monitored during growth to ensure that USFDA action levels or other relevant criteria are not exceeded. Data for the aquaculture crop may be compared with tissue data from local species similar to the aquaculture species. (Lantz-PTT)
W91-07213

HERBICIDES IN WATER: ECONOMICS OR ENVIRONMENT.
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
For primary bibliographic entry see Field 4A.
W91-07220

ACIDIC PRECIPITATION. VOLUME 4: SOILS, AQUATIC PROCESSES, AND LAKE ACIDIFICATION.
For primary bibliographic entry see Field 5B.
W91-07227

SNOWPACK STORAGE OF POLLUTANTS, RELEASE DURING MELTING, AND IMPACT ON RECEIVING WATERS.
National Water Research Inst., Burlington (Ontario). Rivers Research Branch.
For primary bibliographic entry see Field 5B.
W91-07231

PALEOECOLOGICAL ANALYSIS OF LAKE ACIDIFICATION TRENDS IN NORTH AMERICA AND EUROPE USING DIATOMS AND CHRYSOPHYTES.
Indiana Univ. at Bloomington. Dept. of Biology.
D. F. Charles, R. W. Battarbee, I. Renberg, H. Van Dam, and J. P. Smol.
IN: Acidic Precipitation. Volume 4: Soils, Aquatic Processes, and Lake Acidification. Advances in Environmental Science. Springer-Verlag, New York. 1990. p 207-276, 15 fig, 2 tab, 129 ref. EPA Contract 68-C8-0006 and Cooperative Agreement CR-813933-01-1 with Indiana University.

Descriptors: *Acid lakes, *Acid rain, *Acidification, *Chrysophyta, *Diatoms, *Paleoecology, *Water pollution effects, Adirondack Mountains, Air pollution, Europe, Hydrogen ion concentration, Literature review, Quebec, United Kingdom, Water quality.

Analysis of sediment diatom and chrysophyte assemblages is the best technique currently available for inferring past lake water pH trends, and use of this approach is increasing rapidly. Sediment-core inferred pH data exist for at least 100 lakes in both North America and Europe. This number will approximately double within the next 2 years. The pH inference equations are based on at least 15 calibration data sets for North America and 10 for Europe, involving totals of at least 500 and 300 lakes, respectively. Paleoecological studies indicate that recent acidification has been caused by acidic deposition in the Adirondack Mountains (New York), northern New England, Ontario, Quebec, and Canadian Atlantic provinces in North America; England, Scotland, and Wales in the United Kingdom; and Norway, Sweden, Finland, The Netherlands, and West Germany in Europe. Inferred pH decreases are commonly as much as 0.5 to 1.5 pH units. No acidification trends were observed in regions currently receiving low deposition of strong acids (e.g., Rocky Mountains and Sierra Nevada in the western United States, northwestern Norway, and northwestern Scotland). Slight or no trends toward decreasing pH were observed in study lakes receiving moderately acidic deposition (upper Midwest and northern Florida, United States). The magnitude of pH decline in lakes studied is greater, on the average, in Europe than in North America. The amount of inferred acidification (increase in H(+) concentration) correlates with the amount of S and N loading and the ability of watersheds and lakes to neutralize acidic inputs, and is generally consistent with current lake acidification models. (See also W91-07227) (Lantz-PTT)
W91-07235

IS THE ACTIVITY OF BENTHIC SUSPENSION FEEDERS A FACTOR CONTROLLING WATER QUALITY IN THE BAY OF BREST.
Universite de Bretagne-Occidentale, Brest (France). Lab. d'Oceanographie Biologie.
For primary bibliographic entry see Field 2L.
W91-07330

CONSPICUOUS DECLINE OF FUCUS IN KIEL BAY (WESTERN BALTIC): WHAT ARE THE CAUSES.
Kiel Univ. (Germany, F.R.). Inst. fuer Meereskunde.
For primary bibliographic entry see Field 2L.
W91-07331

KINETICS OF SULFATE DESORPTION FROM TWO SPODOSOLS OF THE LAURENTIANS, QUEBEC.
Montreal Univ. (Quebec). Dept. of Geography.
F. Courchesne, and W. H. Hendershot.
Soil Science SOSCAK, Vol. 150, No. 6, p 858-866, December 1990. 5 fig, 3 tab, 21 ref.

Descriptors: *Acid rain effects, *Adsorption kinetics, *Desorption, *Groundwater pollution, *Kinetics, *Laurentian Mountains, *Path of pollutants, *Quebec, *Soil chemistry, *Spodosols, *Sulfates, Kinetic equations, Mathematical models, Rate constants, Regression analysis, Soil horizons, Temporal distribution.

The kinetics of sulfate desorption from two Spodosols at different levels of antecedent sulfate sorption was investigated using a batch technique. The release of sulfate from the B horizons of these soils was measured for periods ranging from 15 minutes to 96 hours at 5, 25, and 40 C. Of the five simple kinetic equations (Elovich, first-order, second-order, parabolic diffusion, and power function) tested the best representation of the time-dependent desorption of sulfate was obtained with the Elovich equation. Desorption kinetics was also adequately described using the power function equation although standard errors of estimate were higher than for the Elovich model. In both horizons, sulfate desorption was rapid during the first 2 hours of reaction. In fact, about 50% of the sulfate desorbed during the experiment was released in the first five minutes. After 4 days of reaction, however, desorption was still proceeding slowly. The slopes of the regression equations (apparent rate coefficient) for the Elovich model increased with increasing reaction temperature. These results show the necessity of considering soil temperature when modeling the seasonal movement of sulfate and of associated cations in soil solution. Of the two horizons studied, adsorbed sulfate reservoir depletion occurred proportionally more rapidly from the Laflamme B horizon. (Author's abstract)
W91-07333

CATION REMOVAL DURING APPLICATION OF ACID SOLUTIONS INTO AIR-DRY SOIL COLUMNS.
NSI Technology Services Corp., Ada, OK.
For primary bibliographic entry see Field 5B.
W91-07357

PAST AND RECENT OCCURRENCES OF MALACOSTRACA GLACIAL RELICTS IN POLISH LAKES.
Marine Biology Center, Al. Wojska Polskiego 11/13, 80-277 Gdansk, Poland.
For primary bibliographic entry see Field 2H.
W91-07371

RECENT DISTRIBUTION OF GLACIAL RELICT MALACOSTRACA IN THE WESTERN AND SOUTHERN BALTIC.
Rostock Univ. (German D.R.). Sektion Wirtschaftswissenschaften.
For primary bibliographic entry see Field 2L.
W91-07372

RECENT DISTRIBUTION OF GLACIAL RELICT MALACOSTRACA IN THE LAKES OF MECKLENBURG.
Rostock Univ. (German D.R.). Sektion Wirtschaftswissenschaften.
For primary bibliographic entry see Field 2H.
W91-07373

EMBRYONIC AND LARVAL DEVELOPMENT OF BROWN TROUT, SALMO TRUTTA L.: EXPOSURE TO ALUMINIUM, COPPER, LEAD OR ZINC IN SOFT, ACID WATER.
Nottingham Univ. (England). Dept. of Zoology.
M. D. J. Sayer, J. P. Reader, and R. Morris.
Journal of Fish Biology JFIBA9, Vol. 38, No. 3, p 431-455, March 1991. 6 fig, 4 tab, 35 ref. Natural Environment Research Council Grant GR3/6176.

Descriptors: *Trout, *Water pollution effects, *Acid rain, *Trace metals, *Aluminum, *Copper, *Lead, *Zinc, *Acidic water, *Fish management,

Fish physiology, Growth stages, Fish eggs, Survival, Mortality, Hatching, Calcium, Sodium, Potassium, Tissue analysis.

Freshly fertilized ova, eyed ova, and yolk-sac fry of brown trout, Salmo trutta, were exposed to each of four trace metals (aluminum, copper, lead, zinc) while held in flowing artificial soft-water media at pH 4.5 or 5.6 and Ca 20 or 200 micromol/L. Survival was severely affected at pH 4.5 and Ca 20 micromol/L regardless of the presence of Cu, Pb, or Zn; Al reduced embryonic mortality and improved hatching success. High ambient Ca at pH 4.5 increased egg survival. Al and Cu impaired skeletal calcification at pH 5.6 at both ambient Ca concentrations; Pb only at Ca 20 micromol/L. Zn enhanced calcification at pH 4.5 and Ca 200 micromol/L. In the absence of trace metals, low pH reduced body Ca, Na, K content, and skeletal calcification at Ca 200 micromol/L. The uptake of Ca, Na, and K, measured at regular intervals from hatching was impaired to the same extent by all treatments at pH 4.5, irrespective of ambient Ca or trace metal presence. At pH 5.6, irrespective of ambient Ca, Al, Cu, and Pb impaired Ca and K uptake. The rate of Na uptake was reduced by Al and Cu. Al-treated yolk-sac fry, exposed to low ambient Ca from 200-300 days post-hatch, suffered high mortality regardless of pH. Ca, Na, and K uptake was impaired by all treatments at pH 4.5, and by Al and Cu at pH 5.6 in a similar exposure period. (Author's abstract)
W91-07394

MANAGED COASTAL WATERS FOR OYSTER CULTURE IN JAPAN.
National Research Inst. of Aquaculture, Mie (Japan). Fish Nutrition Div.
For primary bibliographic entry see Field 8I.
W91-07423

CHANGING ATMOSPHERE: IMPLICATIONS FOR AGRICULTURE.
Agricultural Research Service, Beltsville, MD. Climate Stress Lab.
For primary bibliographic entry see Field 5G.
W91-07445

CARBON DYNAMICS IN EUTROPHIC, TEMPERATE LAKES.
For primary bibliographic entry see Field 2H.
W91-07447

CARBON METABOLISM AND COMMUNITY REGULATION IN EUTROPHIC, TEMPERATE LAKES.
Copenhagen Univ., Hilleroed (Denmark). Det Ferskvands-Biologiske Lab.
For primary bibliographic entry see Field 2H.
W91-07453

BIOLOGICAL PROCESSES IN TOXIC WASTE TREATMENT.
Windsor Univ. (Ontario). Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 5D.
W91-07462

MECHANISMS OF FOREST RESPONSE TO ACIDIC DEPOSITION.
Springer-Verlag New York, Inc., New York. 1990. 245p. Edited by Alan A. Lucier and Sharon G. Haines.

Descriptors: *Acid rain, *Acid rain effects, *Acidic soils, *Acidification, *Ecological effects, *Forest ecosystems, Bioavailability, Dry deposition, Forest hydrology, Forest soils, Geochemistry, Nutrient concentrations, Reviews, Soil organisms, Soil properties, Trees.

Several key mechanisms by which forest ecosystems might respond to acidic deposition are addressed. These mechanisms have been identified in numerous research papers and general review articles during the past decade. The reviews presented analyze the mechanisms in detail and develope specific recommendations for further research. There is an overview of acidification of forest ecosystems; a complex process controlled by numerous hydrologic, geochemical, and biological factors. The effects of acidic deposition on the chemical form and bioavailability of soil aluminum and manganese, and on soil organisms are reviewed. In addition dry deposition, pollutant damage, and forest health using throughfall studies are evaluated, rates of nutrient release by mineral weathering are reviewed, and linkages of the atmosphere and rhizosphere that have potential significance for forest tree health are discussed. (See W91-07466 thru W91-07471) (VerNooy-PTT)
W91-07465

OVERVIEW AND SYNTHESIS.
National Council of the Paper Industry for Air and Stream Improvement, Inc., New York.
A. A. Lucier, and S. G. Haines.
IN: Mechanisms of Forest Response to Acidic Deposition. Springer-Verlag New York, Inc., New York. 1990. p 1-9. 23 ref.

Descriptors: *Acid rain, *Acid rain effects, *Acidic soils, *Acidification, *Ecological effects, *Forest ecosystems, *Forest soils, Forest hydrology, Geochemistry, Leaching, Reviews, Soil organisms, Soil properties, Trees, Weathering.

Acidification of forest ecosystems is a complex process controlled by numerous hydrologic, geochemical, and biological factors. A review of this topic is presented covering foliage leaching, aluminum mobilization, mineral weathering and soil biology. In addition, the future directions in research on acidic deposition effects in forest ecosystems are examined. There is a need for more precise definition of the mechanisms relating to acidic deposition and a need for an ecosystems approach in acidic deposition. Acidic deposition does alter forest ecosystem processes but has not been shown to pose an immediate threat to the health and productivity of commercial forests in North America. However, the potential long-term effects of acidic deposition on forest ecosystems are not yet adequately defined. (See also W91-07465) (VerNooy-PTT)
W91-07466

EVALUATION OF DRY DEPOSITION, POLLUTANT DAMAGE, AND FOREST HEALTH WITH THROUGHFALL STUDIES.
Smithsonian Environmental Research Center, Edgewater, MD.
G. G. Parker.
IN: Mechanisms of Forest Response to Acidic Deposition. Springer-Verlag New York, Inc., New York. 1990. p 10-61. 2 tab, 6 fig, 345 ref.

Descriptors: *Acid rain, *Acid rain effects, *Chemistry of precipitation, *Dry deposition, *Forest ecosystems, *Throughfall, Acidification, Buffering, Canopy, Ecological effects, Forest hydrology, Nutrient transport, Reviews, Solutes, Stemflow, Trees.

Literature on the alteration of precipitation chemistry by forest canopies, with emphasis on canopy buffering of acidic precipitation and the influence of dry deposited pollutants on throughfall chemistry is summarized. Field studies involving forest trees are emphasized, although reference is made to the literature on crop species, and that on laboratory experiments, where necessary. Specific topics covered are uptake and release of solutes by forest canopies, the use of throughfall to estimate dry deposition, effects of pollutants on canopy solute interactions, and throughfall and forest health. Despite some general understanding of throughfall and stemflow chemistry (e.g., its importance relative to other nutrient cycling pathways), it is concluded that there is little understanding of the mechanisms and rates of processes contributing to the alteration of solute chemistry by forest canopies. (See also W91-07465) (VerNooy-PTT)
W91-07467

EFFECTS OF ACIDIC DEPOSITION ON THE CHEMICAL FORM AND BIOAVAILABILITY OF SOIL ALUMINUM AND MANGANESE.
DowElanco, Midland, MI. Environmental Chemistry Lab.
J. D. Wolt.
IN: Mechanisms of Forest Response to Acidic Deposition. Springer-Verlag New York, Inc., New York. 1990. p 62-107. 2 tab, 226 ref.

Descriptors: *Acid rain, *Acid rain effects, *Acidic soils, *Acidification, *Aluminum, *Forest soils, *Manganese, *Soil chemistry, Bioavailability, Chemical interactions, Forest hydrology, Geochemistry, Heavy metals, Reviews, Soil contamination, Soil properties, Soil solution, Toxicity, Trees.

The indirect effect of acidic deposition on forest ecosystems is often equated with accelerated development of acid soil infertility, which is manifested in the sometimes concurrent factors of hydrogen, aluminum (Al), and manganese (Mn) toxicities, and calcium, magnesium, and molybdenum deficiencies. This review considers the potential for acidic deposition-induced development of acid soil infertility through increased Al and Mn bioavailability in forest soils. The hypothesized effects of acidic deposition on soil Al and Mn will most likely be manifested in altered amounts and distribution of chemical forms of Al and Mn in soil solution. These effects on soil solution Al and Mn would have a direct bearing on bioavailability of Al and Mn as well as a subtler long-term influence on solid-phase pools of Al and Mn. Since acidic deposition effects are of great concern in forest ecosystems, the review emphasizes a forest soil perspective, but also reviews a great deal of information stemming from soil chemists' understanding of agricultural ecosystems. Because acidic deposition research has not yet provided a lucid explanation of the role of atmospheric deposition in soil chemical processes, the limited literature concerning acidic deposition is discussed within the broader context of literature concerning the soil chemistry and phytotoxicity of Al and Mn. (See also W91-07465) (VerNooy-PTT)
W91-07468

EFFECTS OF ACIDIC DEPOSITION ON SOIL ORGANISMS.
Oregon State Univ., Corvallis. Dept. of Soil Science
D. D. Myrold.
IN: Mechanisms of Forest Response to Acidic Deposition. Springer-Verlag New York, Inc., New York. 1990. p 163-187. 4 tab, 156 ref.

Descriptors: *Acid rain, *Acid rain effects, *Acidic soils, *Acidification, *Forest soils, *Soil chemistry, *Soil organisms, Deposition, Ecological effects, Forest ecosystems, Nitrogen oxides, Nutrient concentrations, Reviews, Soil bacteria, Sulfur oxides.

Many recent studies of atmospheric deposition effects on soil organisms and biological processes have been concerned with regional-scale pollution problems and the possible influence of acidic deposition on soil biology. This review incorporates many recent investigations and serves as an update of earlier reviews on acidic deposition impacts on soil organisms. It also attempts to present information in a format that permits evaluation of potential effects of current deposition levels. Emphasis is given to effects of acidity and ionic oxides of sulfur and nitrogen. Effects of gaseous pollutants commonly associated with acidic deposition (i.e., sulfur dioxide, nitrogen oxides, ozone) are considered where appropriate. Topics covered include: (1) an introduction to the components of acidic deposition and the direct and indirect mechanisms of their effects on soil organisms; (2) an in-depth look at the research findings on the effects of acidic deposition on populations of soil organisms; and (3) an examination of research on the effects of atmospheric inputs and soil biological activity. It was concluded that acidic deposition, especially at high loading rates, definitely affects soil organisms and biological processes. High inputs of acidity (>10 kmol H(+)/ha/yr) usually decrease populations of

soil organisms and decrease biological activity. The effects of gaseous components, like O3, SOx, and NOx, may be both direct (increased nitrogen and sulfur fertility) and indirect, through their effect on plants. Consequently, their impact is more difficult to assess. (See also W91-07465) (Ver-Nooy-PTT)
W91-07470

ATMOSPHERE AND THE RHIZOSPHERE: LINKAGES WITH POTENTIAL SIGNIFICANCE FOR FOREST TREE HEALTH.
Yale Univ., New Haven, CT. School of Forestry and Environmental Studies.
For primary bibliographic entry see Field 2G.
W91-07471

ACID WATERS IN WALES.
Monographiae Biologicae Volume 66. Kluwer Academic Publishers, Norwell, Massachusetts. 1990. 337p. Edited by R. W. Edwards, A. S. Gee, and J. H. Stoner.

Descriptors: *Acid rain, *Acid rain effects, *Acid streams, *Acidification, *Air pollution, *Limnology, *Streams, *Wales, *Water pollution effects, Aluminum, Analytical methods, Calcium, Ecology, Hydrogen ion concentration, Land use, Mathematical models, Pollution effects, Precipitation, Reservoirs, Stream biota, Water chemistry, Watersheds.

Research on the process of stream acidification and its impact on Welsh surface waters, carried out over the past decade is presented. Clear evidence of stream acidification was first assembled in Wales in the 1980's. It had mistakenly been assumed that, with its prevailing westerly winds, Wales would receive precipitation substantially unpolluted by the industrial and urban emissions from Britain and mainland Europe. Studies in the vicinity of Llyn Brianne reservoir in central Wales demonstrated a clear correlation between the biological quality and fisheries of streams in the catchment and stream chemistry, particularly pH, aluminum and calcium and catchment land use. Subsequent studies have been conducted on analytical and experimental investigations of inputs, pathways and effects of acid precipitation, taking into account the potentially modifying effects of forms of land use and management. These studies include the manipulation of land-management practices, particularly the application of lime products; a synoptic survey of stream chemistry at over 100 sites throughout Wales, relating water quality to upstream land use and, wherever possible, establishing the biological status of these sites; palaeoecological studies to establish the historical changes in lake ecosystems and to explore relationships with land use and atmospheric pollution; and development and application of models which facilitate the prediction of changes in the biological and chemical quality of surface waters with changes in emission patterns of atmospheric pollutants and in land use and management practices. These studies have together demonstrated that in a substantial area of upland Wales streams and lakes have either acidified or are likely to acidify over the next century unless there are significant changes in emission and land use policies. (See W91-07473 thru W91-07491) (Agostine-PTT)
W91-07472

CHEMICAL AND ECOLOGICAL EVIDENCE ON THE ACIDIFICATION OF WELSH LAKES AND RIVERS.
University Coll., Cardiff (Wales). School of Pure and Applied Biology.
For primary bibliographic entry see Field 2H.
W91-07473

RECENT ACIDIFICATION OF UPLAND LAKES IN NORTH WALES: PALAEOLIMNOLOGICAL EVIDENCE.
Minnesota Univ., Minneapolis. Limnological Research Center.
For primary bibliographic entry see Field 2H.
W91-07474

ATMOSPHERIC DEPOSITION.
NRA Welsh Region, Cardiff.
A. P. Donald, J. H. Stoner, B. Reynolds, F. Oldfield, and B. Rippey.
IN: Acid Waters in Wales. Monographiae Biologicae Volume 66. Kluwer Academic Publishers, Norwell, Massachusetts. 1990. p 39-53. 8 fig, 1 tab, 19 ref.

Descriptors: *Acid rain, *Acid rain effects, *Acidification, *Air pollution, *Wales, *Water pollution sources, Ammonium, Analytical methods, Calcium, Fuel, Hydrogen ion concentration, Industrial pollution, Lead, Metals, Nitrates, Paleoecology, Precipitation, Sulfates, Trace metals.

In 1984 an intensive survey of 44 sites in Wales was undertaken to identify spatial and seasonal variations of atmospheric deposition. The data on atmospheric deposition obtained in this survey were evaluated. For the survey, sediment cores from nine lakes in Mid and North Wales were investigated using trace metal analysis, carbonaceous particle analysis and magnetic mineral analysis and associated palaeoecological methods. The data discussed refer to Llyn Dulyn in North Wales and are representative of sediment records from the other lakes examined. It is clear from the Llyn Dulyn sediment record that the atmospheric effects of industrial activity have been felt in even the remotest parts of rural Wales for more than a century. Whereas the accumulation of lead and magnetic particles has increased steadily since the late nineteenth century, spherical carbonaceous particles deriving from fossil fuel combustion have shown a particular increase since the 1930's. Atmospheric deposition today is dominated by marine and anthropogenic sources, which together determine the spatial variability of deposition quality. In the west the influence of sea salts results in mean pH being in the range 4.7-5.0. Although sea salts are much less important in the east, considerable neutralization of the high sulfate and nitrate concentrations is afforded by ammonium and calcium, and pH values are comparable to those of the western seaboard. The upland areas receive the most acid deposition, with mean pH in the range 4.4-4.6. The relatively high rainfall in Wales results in annual deposited acidity being comparable to that received in more highly polluted areas. Even if the apparent downward trend of recent years in hydrogen ion concentration continues, the continued occurrence of discrete highly acidic episodes is likely to remain a major source of concern. (See also W91-07472) (Agostine-PTT)
W91-07475

ROLE OF GEOLOGY AND SOILS IN CONTROLLING SURFACE WATER ACIDITY IN WALES.
Institute of Terrestrial Ecology, Grange-over-Sands (England). Merlewood Research Station.
For primary bibliographic entry see Field 5B.
W91-07476

RECENT LAND USE CHANGE.
Saint David's Univ. Coll., Lampeter (Wales). Dept. of Geography.
R. Boon, and D. Kay.
IN: Acid Waters in Wales. Monographiae Biologicae Volume 66. Kluwer Academic Publishers, Norwell, Massachusetts. 1990. p 67-80. 6 fig, 1 tab, 47 ref.

Descriptors: *Acid rain, *Acid rain effects, *Acidification, *Air pollution, *Land reclamation, *Land use, *Surface water, *Wales, Drinking water, Economic aspects, Fish, Forestry, Political aspects, Reforestation, Reviews, Water quality, Water resources management, Watersheds.

Land improvement and moorland reclamation are significant features of recent land use change in upland Wales. Significant research attention has been devoted to the separation of land use and anthropogenic deposition factors in explaining surface waters acidification. Much less attention has been devoted to defining the degree to which land use change can alter the susceptibility of a region to existing acidic precipitation. A review of the literature pertaining to land use change and its effects on water quality in upland Wales is given from the perspectives of agricultural use, afforestation and economic policy. The results presented suggest the following: (1) upland land use change is responsive to government policy through subsidies and price support; (2) upland land use has a significant effect on the susceptibility of an upland catchment to acidification; and (3) deliberate management of upland catchment land use can have significant effects on the acidification of surface waters. No system exists for land use planning in upland Britain. Decisions on land use change are taken up by individual farmers and commercial forestry interests. It is clear that these decisions affect society in many ways including aesthetic impacts and access restrictions which have caused past controversy. Impacts on surface water quality, important for potable and salmonid waters in Wales, should be added to these other considerations. Given this range of effects a strong case exists for a more formal system of upland land use planning in Britain. (See also W91-07472) (Agostine-PTT)
W91-07477

ACIDIFIED WELSH LAKES: THE SIGNIFICANCE OF LAND USE AND MANAGEMENT.
University Coll., London (England). Palaeoecology Research Unit.
S. T. Patrick, and A. C. Stevenson.
IN: Acid Waters in Wales. Monographiae Biologicae Volume 66. Kluwer Academic Publishers, Norwell, Massachusetts. 1990. p 81-91. 2 fig, 1 tab, 33 ref.

Descriptors: *Acid rain effects, *Acidification, *Lake acidification, *Land management, *Land use, *Wales, Acid rain, Air pollution, Analytical methods, Forests, Hydrogen ion concentration, Lakes, Liming, Moorlands, Organic soils, Oxidation, Peat, Reforestation, Water quality, Watershed management.

The Palaeoecology Research Unit at University College in London is investigating the history and causes of acidification in ten lakes in mid and north Wales. Palaeoenvironmental techniques are being used to reconstruct the historical water quality (particularly pH) of these lakes and the history of atmospheric deposition of metals and combustion products as recorded in the lake sediments. The use of pollen analysis and documentary sources to examine the significance of land use and land management changes in lake catchments was also evaluated. All the lakes studied lie in moorland areas. Eight of the catchments comprise open moorland utilized for rough grazing, while two have been afforested. The lake waters are acid, with pH ranging from 4.8 to 5.6 in unlimed lakes. Diatom based pH reconstruction and atmospheric deposition histories indicate that the acidification of eight of the study lakes is a recent phenomenon that has occurred within the past 120 to 40 years. Apart from afforestation at two sites and water level manipulation at another there has been no land use change in the Welsh study catchments. At the afforested sites, acidification was shown to have commenced before plantation. Further work is in progress to assess whether afforestation enhanced acidification by scavenging processes and to what extent the exposure and oxidation of organic peats by forestry management practices have further contributed to the decline in pH of the lake waters. Changes in land management have occurred in all catchments. There is no evidence that management change has resulted in lake acidification at any one site, much less that any general process of land use or land management has given rise to a general acidification mechanism. The failure to attribute acidification of Welsh lakes to catchment processes strongly argues for an explanation in terms of acid precipitation. (See also W91-07472) (Agostine-PTT)
W91-07478

ROLE OF ACIDITY IN THE ECOLOGY OF WELSH LAKES AND STREAMS.
University Coll., Cardiff (Wales). School of Pure and Applied Biology.
S. J. Ormerod, and K. R. Wade.

IN: Acid Waters in Wales. Monographiae Biologicae Volume 66. Kluwer Academic Publishers, Norwell, Massachusetts. 1990. p 93-119. 8 fig, 1 tab, 94 ref.

Descriptors: *Acid rain, *Acid rain effects, *Acidification, *Ecology, *Lakes, *Streams, *Wales, Air pollution, Algae, Aluminum, Amphibians, Bacteria, Bioindicators, Birds, Calcium, Chemical properties, Fish, Flora, Fungi, Hydrogen ion concentration, Macroinvertebrates, Mammals, Primary productivity, Reviews, Stream biota, Water chemistry.

Ecological studies into the role of acidity and related factors, such as aluminum and calcium concentration, in the ecology of Welsh lakes and streams are reviewed. Data are mainly drawn from a regional survey, undertaken by the Welsh Water Authority (WWA) in 1984, or from the catchment-based study around Llyn Brianne, and relate mostly to river systems. The areas reviewed include: (1) primary producers such as algae and macro-flora; (2) bacteria and fungi; (3) secondary and tertiary production (macroinvertebrates); (4) tertiary production (fish and amphibia) (5) tertiary production (birds and mammals). Overall Welsh studies have revealed strong relationships between pH, or its related chemistry, and the ecology of Welsh lakes and streams. Most evidence is of qualitative differences between water bodies of different pH, apparent in several trophic levels from primary producers to aquatic and semi-aquatic carnivores. In some cases, such as fish, low pH or elevated aluminum concentration probably act directly on the organism. Other groups, such as some riverine birds, are probably affected indirectly through their food supply. In invertebrates, both direct and indirect effects are possible, and may well be inter-related. Qualitative biological differences between acidic and circumneutral freshwaters provide several options for using 'biological indicators' for assessing spatial and temporal patterns in surface water chemistry. Careful appraisal and further research is required so that biological indicator systems can be developed for detecting both episodic and chronic patterns in stream chemistry. (See also W91-07472) (Agostine-PTT)
W91-07479

EFFECTS OF ACIDIFICATION ON FISH AND FISHERIES IN WALES.

NRA Welsh Region, Caernarfon.
N. J. Milner, and P. V. Varallo.
IN: Acid Waters in Wales. Monographiae Biologicae Volume 66. Kluwer Academic Publishers, Norwell, Massachusetts. 1990. p 121-143. 8 fig, 5 tab, 39 ref.

Descriptors: *Acid rain, *Acid rain effects, *Acidification, *Aluminum, *Fish, *Fisheries, *Heavy metals, *Toxicity, *Wales, Biological studies, Buffer capacity, Economic aspects, Forestry, Hydrogen ion concentration, Salmon, Sea trout, Stream biota, Trout, Water resource management.

Welsh freshwater fisheries are dominated by the salmonids: Atlantic salmon (Salmo salar), sea trout and non-migratory brown trout (S. trutta), which constitute an important national resource. These resources are vulnerable to acidification because salmonids are particularly sensitive to low pH, and because their spawning and rearing habitats are typically found in those areas where, through characteristics of high annual deposition and poor buffering capacity, acidification can be anticipated. In order to define the regional extent of the impact of acidification, evidence of diagnostic symptoms in individual fish is examined and some responses of salmonid populations are described. The pattern of fishery impacts in Wales is a mosaic of many populations in various stages of response. Although severe effects are still localized, and mainly confined to Mid and North Wales, preliminary estimates indicate that the potential regional scale of damage in biological and economic terms may be considerable. The management consequences are already significant. Forestry exerts a major influence on the distribution of acidification, in sensitive areas invariably operating through increasing aluminum concentrations. Although aluminum toxicity is a major component of the acid-water phenomenon, in some catchments pH seems to be the limiting factor. Habitat variables and other pollutants such as heavy metals, must be better understood before direct effects of pH/Al toxicity can be clearly identified. Sublethal effects in salmonids have been difficult to detect against natural background variation. Fisheries impacts can, at present, only be recognized when recruitment failure is sufficient to be reflected in population characteristics; by which time acidification will be well advanced. (See also W91-07472) (Agostine-PTT)
W91-07480

ACID DEPOSITION: DRINKING WATER QUALITY AND HEALTH.

Welsh Water Authority, Powys.
C. B. Buckley, and L. Keil.
IN: Acid Waters in Wales. Monographiae Biologicae Volume 66. Kluwer Academic Publishers, Norwell, Massachusetts. 1990. p 145-158. 1 fig, 5 tab, 20 ref.

Descriptors: *Acid rain, *Acid rain effects, *Acidification, *Drinking water, *Public health, *Wales, *Water quality, Alkalinity, Aluminum, Economic aspects, Hydrogen ion concentration, Lead, Manganese, Surface water, Water quality standards, Water treatment.

The standards set by European Community (EC) legislation for those parameters affected by acidification, in both 'source' and 'treated' waters, along with public health implications of water quality changes are examined. The adverse consequences of acidification or treatment processes and costs for both the Welsh Water Authority (WWA) and owners of private supplies are also considered. The effects of acidification of specific water quality parameters was evaluated. The parameters evaluated included: (1) pH and alkalinity; (2) color; (3) manganese content; (4) iron content; (5) aluminum content; and (6) lead content. Water treatment in Wales reflects the predominantly rural nature of the Principality. The majority of treatment works are small, with approximately 50% supplying populations of less than 5000. Many of the smaller works cannot cope adequately with seasonal and climatic water quality variations. The extent to which acidification is involved in such variations is extremely difficult to assess but it is likely that in the acid sensitive areas of Wales it affects process efficiency and leads to increased operating costs. While compliance with the EC 'Surface Water' and 'Drinking Water' Directives affords protection of drinking water supplies, there is a need for an immediate policy review regarding alkalinity and aluminum. In the short term, acidification of source waters which are treated by WWA is most unlikely to cause any adverse health effects to the customer. If current water quality standards are to be maintained in the longer term, considerable capital and revenue costs may be incurred. The effects of acidification on private supplies are more readily identifiable as many have inadequate treatment or none at all. It is essential that remedial action is implemented in acid sensitive areas to reduce the problems associated with corrosion. (See also W91-07472) (Agostine-PTT)
W91-07481

ECOTOXICOLOGICAL STUDIES OF ACIDITY IN WELSH STREAMS.

University Coll., Cardiff (Wales). School of Pure and Applied Biology.
N. S. Weatherley, C. P. McCahon, D. Pascoe, and S. J. Ormerod.
IN: Acid Waters in Wales. Monographiae Biologicae Volume 66. Kluwer Academic Publishers, Norwell, Massachusetts. 1990. p 159-172. 4 fig, 2 tab, 50 ref.

Descriptors: *Acid rain, *Acid rain effects, *Acidification, *Acidity, *Liming, *Streams, *Toxicology, *Wales, *Water pollution effects, Aluminum, Ecology, Fauna, Field tests, Fish, Hydrogen ion concentration, Invertebrates, Littoral zone, Salmon, Storms, Toxicity.

The effects of short term 'acid episodes', conditions often associated with heavy rain or snowmelt, and characterized in streams by increased flow, decrease in pH and increase in aluminum concentrations were studied. A series of acid episodes was simulated in the field and the biological responses were monitored in an attempt to copy natural events as closely as possible. Over the course of three experiments, one per year from 1985 to 1987, the effects of low pH, low pH with high aluminum concentrations (both labile and organically complexed), and lime treated water were compared. Exposure of fish to elevated hydrogen ion and aluminum concentrations around pH 5 was consistently associated with loss of body Na(+), Cl(-) and K(+). Results demonstrate that H(+) and Al effects can be alleviated by liming, which raises the pH and concentrations of Ca(2+). The mechanisms of acid-aluminum toxicity in invertebrates may be analogous to those in fish. Aluminum is generally most toxic near pH 5. Impairment of gas exchange and ion regulation have been suggested as the two main toxic pathways. Important conclusions can be drawn from toxicity data concerning short-term exposure to acid conditions. Acid episodes can rapidly cause acute toxic responses in a number of taxa, ranging from grazing invertebrates to carnivorous salmonid fish. The importance of these effects is supported by field observations of natural episodes. These observations are particularly relevant to natural waters which generally have circumneutral pH but are subject to acid episodes and to limed waters. In limed running waters, acid episodes are often not eliminated, and in limed lakes, influxes of acid water to the littoral zone frequently occur. Thus liming without the elimination of episodes may not allow full recovery of the fauna. (See also W91-07472) (Agostine-PTT)
W91-07482

MODELLING THE ECOLOGICAL IMPACT OF CHANGING ACIDITY IN WELSH STREAMS.

University Coll., Cardiff (Wales). School of Pure and Applied Biology.
S. J. Ormerod, N. S. Weatherley, and A. S. Gee.
IN: Acid Waters in Wales. Monographiae Biologicae Volume 66. Kluwer Academic Publishers, Norwell, Massachusetts. 1990. p 279-298. 8 fig, 1 tab, 34 ref.

Descriptors: *Acid rain, *Acid rain effects, *Acid streams, *Acidification, *Ecological effects, *Model studies, *Streams, *Wales, *Water chemistry, Acidity, Coniferous forests, Fauna, Fish, Invertebrates, Mathematical studies, Regional analysis, Trout.

The development of ecological models for Welsh streams was examined. The ecological models were used in conjunction with the hydrochemical model MAGIC (Model of Acidification of Groundwater in Catchments) to generate temporal patterns in three catchments around Llyn Brianne, and in Welsh the 'acid sensitive' region as a whole. The approach has been to use the output from a process model (MAGIC) to drive linear empirical models which 'predict': (1) the toxic response of brown trout; (2) brown trout density; and (3) changes in invertebrate fauna. Several features of this modeling exercise are of interest. First, the patterns generated by the models indicate a considerable reduction in salmonid abundance in soft-water streams around Llyn Brianne, and throughout upland Wales, between the 19th century and present day. This feature is corroborated by the survival model. Second, the acidifying influences of conifer forest severely exacerbate aluminum concentrations in the soft-water streams at Llyn Brianne, almost totally eliminating fish populations and causing changes in invertebrate populations by 1984. The influences of forest on fish and invertebrates would not be reversed, according to the model, in spite of deposition reduction by 50%. Third, the models also suggest that, despite reduced deposition, pronounced increases in fish abundance will not occur in moorland streams at Llyn Brianne within the simulated time frame. The extrapolation to other areas, in the regional analysis, indicated that fish survival could be maintained following a 50% reduction in deposition. (See also W91-07472) (Agostine-PTT)
W91-07489

ACIDIC PRECIPITATION, VOL. 1: CASE STUDIES.
Advances in Environmental Science. Springer-Verlag New York, Inc., New York. 1989. 311p. Edited by D. C. Adriano and M. Havas.

Descriptors: *Acid rain, *Acid rain effects, *Acidification, *Air pollution effects, *Biogeochemistry, *Case studies, *Ecological effects, Aluminum, Fish populations, Forests, Hydrogen ion concentration, Soil chemistry, Water chemistry, Watersheds.

As has been the case with many environmental issues of the twentieth century, acidic precipitation has its origin in emissions to the atmosphere of numerous compounds from both natural and manmade sources. This volume of the subseries 'Acidic Precipitation' emphasizes some of the classical interactions between acidic deposition and ecological effects. It covers the cycling, behavior, and effects of acidic components in nature. Included are the effects of acidic deposition on soil chemistry, soil solution chemistry, aquatic chemistry, forest productivity, and fish populations. Several major ecological consequences, such as a decline in forest productivity, soil and water acidification, depletion of fish populations, and slower litter decomposition are highlighted. A chapter is devoted to the comparative biogeochemistry of aluminum, encompassing several ecosystems in North America and Europe. (See W91-07493 thru W91-07501) (Agostine-PTT)
W91-07492

ACIDIC DEPOSITION ON WALKER BRANCH WATERSHED.
Oak Ridge National Lab., TN. Environmental Sciences Div.
D. W. Johnson, and S. E. Lindberg.
IN: Acidic Precipitation, Vol. 1: Case Studies. Advances in Environmental Science. Springer-Verlag New York, Inc., New York. 1989. p 1-38. 15 fig, 3 tab, 82 ref.

Descriptors: *Acid rain, *Acid rain effects, *Acidification, *Case studies, *Path of pollutants, *Walker Branch Watershed, *Watersheds, Air pollution, Canopy, Ecological effects, Ecosystems, Fate of pollutants, Forests, Leaching, Mineralization, Nitrogen, Nutrients, Soil chemistry, Soil solution, Sulfur, Throughfall.

Two research projects were initiated in 1981 at the Walker Branch Watershed in Tennessee to study the effects of atmospheric pollutants (acidic precipitation) on canopy processes and soil chemistry. The approach has been to make both ecosystem and process-level measurements of the inputs, canopy interactions and internal cycling, to determine the ultimate fate of atmospherically deposited substances, and from that information, to deduce the effects of such deposition on the ecosystem. Several conclusions as to the fate and effects of atmospheric pollutants can be drawn. On Walker Branch Watershed dry deposition is a very important component of atmospheric deposition, accounting for as much as half the input of N and S to the ecosystem. Both N and S accumulate within the watershed, but with different mechanisms: N accumulation is due to biological uptake, while S accumulation is due to sulfate adsorption onto the soils. The estimated leaching of K(+), Ca(2+), and Mg(2+) from the forest canopy increased by roughly 50% due to acid deposition, but the effects of this increase on the forest were not determined. No evidence was found of negative effects of artificial acid irrigation on decomposition of nutrient mineralization, but any chronic, long-term effects of atmospheric deposition on decomposition remain unknown. It was estimated that atmospheric S deposition has increased cation leaching from the soils of Walker Branch Watershed by 50 to 100%. Despite the accelerated rate of leaching, it was calculated that most soils of Walker Branch Watershed have sufficient exchangeable base cation reserves to preclude significant acidification due to acidic deposition in the near future. (See also W91-07492) (Agostine-PTT)
W91-07493

ACIDIC PRECIPITATION: CASE STUDY SOLLING.
Goettingen Univ. (Germany, F.R.). Forschungszentrum Waldoekosysteme - Waldsterben.
E. Matzner.
IN: Acidic Precipitation, Vol. 1: Case Studies. Advances in Environmental Science. Springer-Verlag New York, Inc., New York. 1989. p 39-83. 8 fig, 11 tab, 94 ref, append.

Descriptors: *Acid rain, *Acid rain effects, *Acidification, *Air pollution, *Case studies, *Forest ecosystems, *Germany, *Path of pollutants, Aluminum, Beech trees, Hydrogen ion concentration, Hydroxides, Ion transport, Litter, Nitrification, Organic matter, Rhizosphere, Seasonal variation, Soil chemistry, Soil solution, Spruce trees, Sulfates, Toxicity.

By using the flux-balance approach, the rates of deposition of major elements, including H(+), S, and N, and the effects on ion cycling in the canopy and mineral soil were obtained in two mature forest stands of the north German Solling region. Both stands are heavily impacted by acid precipitation, the spruce (Picea abies Karst.) stand receiving about twice the rate of acidity as the beech (Fagus silvatica L.) stand. The deposition of protons results in increased cation leaching from the leaves and needles with subsequent acidification of the rhizosphere. In both sites the mineralization of above-ground litter was significantly inhibited, and the amount of organic matter in the top layer almost doubled during the period of investigation. The organic top layer appears to be the major sink for deposited N. The Ca/Al and Mg/Al ratios of the soil solution have decreased in both stands to levels posing high risk of Al toxicity to tree roots. According to input-output budgets of the mineral soil, sources of ions are obvious in the case of most major nutrients. In spruce the behavior of sulfate in the mineral soil changed from accumulation to release over the study period. Proton budgets reveal that the most important part of the acid load of the mineral soil stems from the deposition of strong acids. The prevailing buffer mechanism is the release of Al ions from hydroxides, sulfates, and exchangeable sites into the soil solution. The long-term effects of acid deposition on soil chemistry are superimposed by seasonal acidification phases resulting from natural excess nitrification under favorable climatic conditions. In acid soils these acidification phases cause pH reductions and additional Al releases. (See also W91-07492) (Author's abstract)
W91-07494

DECLINE OF RED SPRUCE IN HIGH-ELEVATION FORESTS OF NEW YORK AND NEW ENGLAND.
Pennsylvania Univ., Philadelphia. Dept. of Geology.
A. H. Johnson, T. G. Siccama, W. L. Silver, and J. J. Battles.
IN: Acidic Precipitation, Vol. 1: Case Studies. Advances in Environmental Science. Springer-Verlag New York, Inc., New York. 1989. p 85-112. 18 fig, 3 tab, 63 ref.

Descriptors: *Acid rain, *Acid rain effects, *Acidification, *Case studies, *Forests, *New England, *New York, *Spruce trees, Air pollution, Cloud liquid water, Elevation, Mountains, Ozone, Reviews, Seasonal variation, Stress.

A high rate of red spruce (Picea rubens Sarg.) mortality has been noted in the Adirondack, Green and White Mountains of the northeastern United States over the past two decades. Because spruce mortality is greatest at high elevations where the forest is frequently immersed in cloudwater, and because cloudwater contains high levels of acids and other dissolved chemicals, several hypotheses regarding the role of acid deposition in spruce decline have been formulated. The data that define the nature and timing of the spruce decline, the data relevant to known natural contributors, and data addressing some of the hypotheses implicating acid deposition and other airborne chemicals is summarized. The topics reviewed include: (1) the occurrence of spruce decline; (2) patterns and rates of mortality; (3) relationships between mortality, age, direction of exposure, and elevation; (4) climatic extremes as initiating stresses; (5) influence of insects and diseases; and (6) possibility of air pollution involvement. Although several possibilities remain to be tested, at present no clear mechanistic evidence links acid deposition to spruce decline. Several natural stress factors are associated with the timing and severity of spruce mortality and will likely be judged causal agents. Winter damage (desiccation and/or freezing injury) appears to play a major role as an initiating and synchronizing influence. Experiments carried out with red spruce seedlings showed that realistic levels of ozone had an unfavorable effect on winter hardiness and suggested a way in which air pollution might play a role in the decline. (See also W91-07492) (Agostine-PTT)
W91-07495

ALBIOS: A COMPARISON OF ALUMINUM BIOGEOCHEMISTRY IN FORESTED WATERSHEDS EXPOSED TO ACIDIC DEPOSITION.
Maine Univ., Orono. Dept. of Botany and Plant Pathology.
C. S. Cronan, and R. A. Goldstein.
IN: Acidic Precipitation, Vol. 1: Case Studies. Advances in Environmental Science. Springer-Verlag New York, Inc., New York. 1989. p 113-135. 11 fig, 7 tab, 27 ref. Electric Power Research Institute Contract RP2365-01.

Descriptors: *Acid rain, *Acid rain effects, *Acidification, *Aluminum, *Biogeochemistry, *Case studies, *Forest watersheds, *Path of pollutants, Air pollution, Comparison studies, Distribution patterns, Fish, Geochemistry, Nitrates, Soil chemistry, Solute transport, Streams, Subsurface water, Sulfates, Sulfur, Toxicity, Water chemistry, Wetlands.

A case study of the broad interregional patterns of aluminum toxicity and aluminum biogeochemistry in the forest landscapes of North America and northern Europe is presented. Sulfur deposition at the 14 ALBIOS (aluminum in the biosphere) study catchments ranged 20-fold from approximately 4 kg S/ha-yr at the Experimental Lakes Area, Ontario, to > 80 kg S/ha-yr at Solling, West Germany. Two dominant geochemical patterns were observed in most watersheds: (1) upper soil horizon and wetland zones characterized by aluminum adsorption-desorption reactions on solid-phase humic materials; and (2) mineral soil horizon and groundwater zones dominated by aluminum solubility relationships with some form of Al(OH)3. Much of the overall variation in aquo aluminum ion activity could be explained on the basis of relatively simple equilibrium pH-solubility and adsorption models. The ALBIOS evidence indicated that the relationship between watershed inputs of H2SO4 or HNO3 and outputs of soluble aluminum is not necessarily simple and straightforward. However, for those watersheds characterized by aluminum-saturated soils and low retention of strong acid anions, increased concentrations and fluxes of sulfate and nitrate in soil water were accompanied by increased concentrations and fluxes of soluble aluminum, both on a broad geographic basis and on a single catchment basis. The toxicity thresholds for the sensitive and moderately sensitive tree species were within range of the peak concentrations of soluble aluminum observed in soil solutions at some of the northern and European watersheds. Likewise, soluble aluminum concentrations in many headwater streams were in excess of toxicity thresholds for fish species like brown trout and brook trout. As such, it is likely that aluminum toxicity serves as a contributing stress factor in these kinds of northern watersheds. (See also W91-07492) (Agostine-PTT)
W91-07496

LONG-TERM ACIDIC PRECIPITATION STUDIES IN NORWAY.
Norges Landbrukshoegskole, Aas. Dept. of Soil Sciences.
G. Abrahamsen, H. M. Seip, and A. Semb.
IN: Acidic Precipitation, Vol. 1: Case Studies. Advances in Environmental Science. Springer-Verlag New York, Inc., New York. 1989. p 137-179. 13 fig, 4 tab, 189 ref.

Descriptors: *Acid rain, *Acid rain effects, *Acidification, *Air pollution, *Case studies, *Norway, *Path of pollutants, Aluminum, Anions, Cations, Crustaceans, Ecosystems, Environmental effects, Fish populations, Hydrogen ion concentration, Insects, Ion transport, Leaching, Nitrogen, Nutrients, Plant growth, Salmon, Snails, Soil chemistry, Sulfur, Trees, Trout, Zooplankton.

Long-range transported air pollutants have probably been deposited in Norway for more than 100 years but with a significant increase in the 1950s and 1960s. The deposition of S and N has been fairly constant for the last 15 to 20 years. Norwegian research, conducted by several institutes and universities, is being conducted on long-distance imported air pollutants and their effects on soil, water, vegetation, and humans. Atmospheric acid deposition of acid is likely to increase leaching of cations from soils. This may result in water acidification if H(+) and aluminum ions are leached and in soil acidification if base cations are leached. Sulfate is the most important vehicle for increased leaching from soils. Because N, in the form of NO3(-) and NH4(+), is largely absorbed by vegetation and soil, it does not contribute substantially to the leaching. Increase in soil acidity is a slow process, and dramatic immediate effects on the terrestrial ecosystem are not expected. However, in the long run, increased leaching of base cations is likely to influence the forest negatively. The deposition of N will probably increase tree growth. The combination of increased growth due to N deposition and the increased leaching of base cations could accelerate possible nutrient deficiencies in the future. In the future other terrestrial organisms may also suffer from the atmospheric deposition. Dramatic declines in the populations of fish, particularly trout and salmon, have been taking place during the last century. The decline in fish populations is due to increased water acidity combined with increased concentrations of toxic aluminum species. Other freshwater organisms, including crustacea, snails, insect larvae, and various zooplankton species, also suffer from the acidification. (See also W91-07492) (Author's abstract)
W91-07497

CHEMISTRY OF ROCKY MOUNTAIN LAKES.
Geological Survey, Lakewood, CO.
J. T. Turk, and N. E. Spahr.
IN: Acidic Precipitation, Vol. 1: Case Studies. Advances in Environmental Science. Springer-Verlag New York, Inc., New York. 1989. p 181-208. 11 fig, 28 ref.

Descriptors: *Acid rain, *Acid rain effects, *Acidification, *Mountain lakes, *Pollution effects, *Rocky Mountains, *Water chemistry, Air pollution, Chlorides, Evapotranspiration, Hydrogen ion concentration, Model studies, Seasonal variation, Sulfates, Watersheds.

The results of previous work on the acidification of lakes in the Rocky Mountains are reviewed and an interpretation is given of data from the 1985 Western Lake Survey to determine controls on the chemistry of these lakes. Lakes of the Rocky Mountain region are not chronically acidic. Data generally are unavailable to determine whether episodic acidity is a problem and whether such acidity is anthropogenic. Researchers have hypothesized that decreases in pH of about 0.2 unit have occurred in lakes along the Colorado Front Range between the late 1930s and 1979. Loss of alkalinity, caused by acidic deposition, also has been hypothesized for lakes along the Colorado Front Range and in west-central Colorado. Confirmation of these hypotheses is impossible with present (1978) data. Wetfall is the primary control on chloride and sulfate concentrations in lakes in the Rocky Mountains. Comparison of chloride concentrations in lakes and in wetfall indicates that evapotranspiration is small in most high-elevation lakes having alkalinity less than 200 microeq/L. In addition, comparison of sulfate concentrations in lakes and in wetfall indicates that processes that add sulfate to or remove it from the sulfate concentrations supplied by wetfall rarely change lake sulfate concentrations by more than 50% from wetfall-sulfate concentrations. Data are generally inadequate to calibrate and verify models that might be used to predict the effects of changes in atmospheric deposition of acidity and associated constituents on lake chemistry. The few watersheds for which sufficient data exist still are inadequate to represent the range of conditions that occur in the Rocky Mountains. (See also W91-07492) (Author's abstract)
W91-07498

INFLUENCE OF AIRBORNE AMMONIUM SULFATE ON SOILS OF AN OAK WOODLAND ECOSYSTEM IN THE NETHERLANDS: SEASONAL DYNAMICS OF SOLUTE FLUXES.
Agricultural Univ., Wageningen (Netherlands). Dept. of Soil Science and Geology.
N. van Breeman, P. M. A. Boderie, and H. W. G. Booltink.
IN: Acidic Precipitation, Vol. 1: Case Studies. Advances in Environmental Science. Springer-Verlag New York, Inc., New York. 1989. p 209-236. 10 fig, 7 tab, 27 ref.

Descriptors: *Acid rain, *Acid rain effects, *Acidification, *Air pollution, *Ammonium compounds, *Forest ecosystems, *Forest soils, *Oak trees, *Path of pollutants, *Soil chemistry, *Solute transport, *Sulfates, *The Netherlands, Aluminum, Calcium, Drainage, Magnesium, Model studies, Nitrates, Nitrification, Seasonal variation, Water chemistry.

Three years of hydrochemical monitoring was conducted at three different sites in an oak woodland ecosystem in the Netherlands. Atmospheric inputs, mainly dry deposited ammonium sulfate, are high, and amount to 2 to 3 kmol/ha-yr of ammonium sulfate. Intensive nitrification in the acidic soils (pH 3.5-4) is the main source of H(+) ions in these soils, which in turn causes the mobilization of Al(3+), Ca(2+), and Mg(2+) ions. By combining measurements of solute concentrations and hydrologic modeling to evaluate seasonal hydrology and changes in the storage of solutes, the variation in time and depth of solute transfer between the solid phases and the soil solution has been calculated. Concentrations of nitrate and the cations Al(3+), Ca(2+), and Mg(2+) are generally highest in summer, mainly as a result of evaporative concentration of solutes. Mobilization and leaching of most cations, however, takes place mainly during the fall. During summer, soil acidification is less and confined to a shallow surface layer. Contrary to the other cations, K(+) is weathered most strongly in summer, presumably under the influence of strong depletion by root uptake. Strong soil acidification in the fall appears to be due to a combination of increased net nitrification and increased drainage, both of which are obviously related to decreased physiological activity of the tree vegetation. (See also W91-07492) (Author's abstract)
W91-07499

ACIDIC DEPOSITION: CASE STUDY SCOTLAND.
Newcastle upon Tyne Univ. (England). Dept. of Soil Science.
F. T. Last.
IN: Acidic Precipitation, Vol. 1: Case Studies. Advances in Environmental Science. Springer-Verlag New York, Inc., New York. 1989. p 237-274. 15 fig, 5 tab, 95 ref.

Descriptors: *Acid rain, *Acid rain effects, *Acidification, *Air pollution, *Case studies, *Ecological effects, *Scotland, Bedrock, Diatoms, Fish, Forests, Invertebrates, Leachates, Reforestation, Reviews, Salmon, Soil chemistry, Stemflow, Streams, Throughfall, Trees, Trout.

Acidic deposition in Scotland is reviewed. The pollution climate dominated by wet deposition, is similar to that in parts of southern Norway and Sweden, but differs from those in central England, eastern Belgium, and much of West Germany. The appearance of beech, oak, and Scots pine, but not Norway spruce and Sitka spruce, deteriorates towards the north and west of Britain. Surveys made by the Forestry Commission in 1986 and 1987 found stemflow of 'old' stands of alder, oak, Scots pine, Norway spruce and Sitka spruce was always more acidic than incident precipitation. In contrast, throughfall in alder, oak, and Sitka spruce was less acidic than incident rain during summer and autumn but not at other times. The contribution of foliar leachates is still questionable. Although pollutants have been shown to be capable of affecting soil processes, there is no unequivocal field evidence to show they have exacerbated the natural acidity of soils in Scotland. In contrast, there is substantive evidence from diatom reconstructions to show that atmospheric pollutants have been implicated in the acidification of some freshwaters clustered in Galloway, southwest Scotland. Affected lochs and associated streams drain 'acidification-sensitive' basins with slowly weathering base-poor bedrock: they are subject to heavy rainfall and have therefore been receiving large inputs of deposited acidity. In addition to diatoms, acidification has altered populations of freshwater invertebrates and decreased, if not eliminated, populations of fish, notably salmonids. Afforestation with conifers has exacerbated the acidity of freshwaters in acidification-sensitive locations, as in west-central Scotland. During the last decade amounts of annually deposited acidity have decreased, and at the same time there is evidence indicating that the acidification of some lakes has been halted if not reversed. (See also W91-07492) (Agostine-PTT)
W91-07500

LANGE BRAMKE: AN ECOSYSTEM STUDY OF A FORESTED CATCHMENT.
Goettingen Univ. (Germany, F.R.). Abt. Bodenkunde und Waldernahrung.
M. Hauhs.
IN: Acidic Precipitation, Vol. 1: Case Studies. Advances in Environmental Science. Springer-Verlag New York, Inc., New York. 1989. p 275-305. 9 fig, 14 tab, 32 ref. Umweltbundesamt Prj. 10204350.

Descriptors: *Acid rain, *Acid rain effects, *Acidification, *Forest ecosystems, *Forest watersheds, *Germany, *Path of pollutants, *Seepage, *Watersheds, Aluminum, Biomass, Case studies, Cations, Cloud liquid water, Ions, Leaching, Model studies, Nitrates, Root zone, Runoff, Soil chemistry, Soil solution, Subsurface water, Throughfall, Water chemistry.

The forested catchment of Lange Bramke in the Harz Mountains of Germany has been hydrologically monitored since 1948 when it was clear-cut. Today the catchment is covered by a 38-year-old Norway spruce (Picea abies Karst.) stand. Seepage water pathways through the catchment and ion cycling have been investigated in detail during the past 10 years. The results showed that seepage water through the root zone is vertical and unsaturated at the catchment slopes. The derived model of seepage water trajectories matches the observed chemical gradients between soil solution, headwater, groundwater, and runoff. Acid deposition inside the valley of Lange Bramke is substantial with throughfall means of 45 kg/ha-yr as SO4-S, 10 kg/ha-yr as NO3-N, and 9.1 kg/ha-yr as NH4-N. The fluxes of these ions are significantly higher at the wind-exposed ridge of the catchment. This additional input is probably due to cloudwater capture during winter months. Soil acidification at Lange Bramke is driven by base cation accumulation in the biomass and accelerated leaching of these ions due to acid deposition. Today about one-third of the trees at Lange Bramke and the adjacent catchment of Dicke Bramke are affected by forest decline. This decline is manifested in two symptom types that show a spatially different distribution locally in the Bramke Valley and regionally for the Harz Mountains. Changes in soil solution and runoff chemistry occurred prior to and concurrent with the development of these decline symptoms. Among the changes are increased Al and decreased Ca concentrations over the 10 years of measurement. The fine root biomass in the mineral soil is low where nitrate leaching occurs. Nitrate export with runoff water from both catchments has increased dramatically over the past 10 years. These data provide empirical evidence for linkages among acid deposition, forest decline and water acidification, respectively. (See also W91-07492) (Author's abstract)

W91-07501

ACIDIC PRECIPITATION, VOL. 2: BIOLOGICAL AND ECOLOGICAL EFFECTS.
Advances in Environmental Science. Springer-Verlag New York, Inc., New York. 1989. 368p. Edited by D. C. Adriano and A. H. Johnson.

Descriptors: *Acid rain, *Acid rain effects, *Acidification, *Air pollution, *Biological studies, *Ecological effects, *Ecosystems, Acidic soils, Aluminum, Decomposition, Forest ecosystems, Forest soils, Freshwater, Lakes, Limnology, Microorganisms, Nutrients, Organic matter, Plant growth, Species diversity.

Acidic precipitation has its origin in emissions to the atmosphere of numerous compounds from both natural and man-made sources. The 10 chapters in this volume cover a wide array of topics on the biological and ecological effects of acidic precipitation. A chapter on soil productivity emphasizes changes in biological and chemical characters of forest soils impacted by acidic deposition. Additional chapters discuss specific effects on soil microorganisms, trees, and crops. The importance of aluminum in this environmental issue is highlighted by a discussion on the mobility and phytotoxicity of this element in acidic soils. This chapter puts into perspective the biology of Al stressed plants. Two major chapters discuss the effects of acidic precipitation on forest ecosystems; one emphasizing North America, and the other Europe. Effects of soil acidification on key soil processes, including litter decomposition and depletion of essential plant nutrients in the soil profile are emphasized. Finally, three major chapters comprehensively cover limnological ecosystems and their response to acidic perturbation. These chapters discuss the response of stream and lake communities, both floral and faunal, to water acidification, including reduced biodiversity in these systems. (See W91-07503 thru W91-07512) (Author's abstract)
W91-07502

EFFECTS OF ACIDIC PRECIPITATION ON TREES.
Georgia Univ., Athens. Dept. of Botany.
B. L. Haines, and C. L. Carlson.
IN: Acidic Precipitation, Vol. 2: Biological and Ecological Effects. Advances in Environmental Science. Springer-Verlag New York, Inc., New York. 1989. p 1-27. 5 tab, 123 ref.

Descriptors: *Acid rain, *Acid rain effects, *Acidification, *Air pollution, *Forests, *Phytotoxicity, *Trees, Comparison studies, Germination, Hydrogen ion concentration, Plant growth, Pollen, Reviews, Root development, Roots.

The effects of acidic rain on pollen germination, pollen tube growth, seed production, seed germination, seedling growth, leaf structure and function, and root structure and function have been reviewed. Acidic rain research frequently involves evaluation of changes in plant processes between groups of plants receiving different simulated acid rain treatments. Results are then compared to controls of pH 5.5 or 5.6. The results of such studies are summarized. Effects on leaves and on tree nutrition are also explored. In short-term laboratory studies, pollen germination and pollen growth are susceptible to inhibition by simulated acidic rain in the range pH 4.0 to 2.5. Ambient acidic rain in eastern North America has a volume-weighted average pH of 4.1 to 4.2. Damage to leaves and roots occurs usually at 1 or 2 pH units below these ambient rainfall pH values. Presently there is no evidence of direct negative effects of acidic rain on tree growth in the field. The potential interactions of acidic rain with other stresses are incorporated into working hypotheses designed by many investigators to account for forest decline/dieback phenomena. (See also W91-07502) (Agostine-PTT)
W91-07503

EFFECTS OF ACIDIC PRECIPITATION ON CROPS.
Manhattan Coll., Bronx, NY. Lab. of Plant Morphogenesis.
L. S. Evans.
IN: Acidic Precipitation, Vol. 2: Biological and Ecological Effects. Advances in Environmental Science. Springer-Verlag New York, Inc., New York. 1989. p 29-60. 120 ref.

Descriptors: *Acid rain, *Acid rain effects, *Acidification, *Agriculture, *Air pollution, *Crops, Field tests, Forests, Plant growth, Productivity, Statistical analysis, Vegetation.

In documenting the effects and impact mechanisms of acidic deposition on plants, consideration was given to those acidic deposition effects that may be present but generally are not or cannot be included in experiments designed to determine plant (crop) productivity. There is evidence that the acidity in precipitation, at ambient levels, is having deleterious effects upon terrestrial vegetation. Experiments have been conducted under controlled-environment conditions but, as plant responses to acidic rain grown under such conditions differ from responses under field conditions, data from controlled environments may only point to mechanisms. Few field experiments have been conducted that are statistically capable of detecting significant differences among treatments. Acidic precipitation may affect the productivity of crop and forest plants by direct or indirect means (necrosis or soil nutrient effects). From available data, it is clear that the amount of injury, if injury occurs, is less than year-to-year changes in other abiotic and biotic factors. This does not mean, however, that possible injuries from acidic precipitation should be ignored. It is important to determine even small changes in productivity. At present, the best available data to understand the effects of acidic precipitation can be derived from experiments using moveable rainfall exclusion shelters. (See also W91-07502) (Agostine-PTT)
W91-07504

EFFECTS OF ACIDIC PRECIPITATION ON SOIL PRODUCTIVITY.
Maine Univ. at Orono. Dept. of Plant and Soil Sciences.
I. J. Fernandez.
IN: Acidic Precipitation, Vol. 2: Biological and Ecological Effects. Advances in Environmental Science. Springer-Verlag New York, Inc., New York. 1989. p 61-83. 2 fig, 2 tab, 98 ref.

Descriptors: *Acid rain, *Acid rain effects, *Acidification, *Air pollution, *Forest soils, *Productivity, *Soil chemistry, Atmospheric chemistry, Heavy metals, Leaching, Nitrogen, Nitrogen cycle, Nutrients, Plant growth, Reviews, Sulfates, Sulfur.

One of the earliest concerns for the potential effects of acidic deposition on forest ecosystems was for accelerated soil acidification and nutrient depletion. Although research on this topic has resulted in significant advances in the understanding of soil response to S, N, and trace metal deposition, little can be concluded at this time as to the consequences of soil changes for forest health and productivity on a regional basis. It is essential to define an understanding in terms of (1) effects on soil productivity capacity versus (2) soil-mediated effects on forest health and growth. Nitrogen cycling in forest soils has been altered, as well as the cycling of other nutrients; soils in acidic deposition-affected regions often contain significant amounts of SO4(2-) in soil solution; trace metals have accumulated in forest soils; and selected ecosystems in high-deposition areas of Europe have exhibited nutrient deficiency symptoms thought to be partially a result of acidic deposition leaching. Although many uncertainties remain, there is little question that air pollution has altered the chemical and biological character of forest soils. How these changes have or will have, an effect on forest health and productivity remains undefined. Some of the difficulty in understanding linkages between soil changes and resulting consequences for forests is due to the lack of long-term data on forest ecosystems and the lack of suitable control sites for experimental research. Complex interactions among varying natural and anthropogenic stresses must also be included to assess realistic consequences of air pollution on forests. (See also W91-07502) (Agostine-PTT)
W91-07505

EFFECTS OF ACIDIC PRECIPITATION ON STREAM ECOSYSTEMS.
Oak Ridge National Lab., TN. Environmental Sciences Div.
J. W. Elwood, and P. J. Mulholland.
IN: Acidic Precipitation, Vol. 2: Biological and Ecological Effects. Advances in Environmental Science. Springer-Verlag New York, Inc., New York. 1989. p 85-135. 4 fig, 150 ref. U.S. DOE Contract DE-AC05-84OR21400, and Electric Power Institute Contract RP2326-1 with Martin Marietta Energy Systems, Inc.

Descriptors: *Acid rain, *Acid rain effects, *Acidification, *Air pollution, *Ecosystems, *Stream acidification, *Stream biota, Bacteria, Benthic fauna, Environmental effects, Fish, Fungi, Hydrogen ion concentration, Macroinvertebrates, Microorganisms, Reviews, Species diversity.

The evidence of causal links between acidic deposition and biological effects on stream organisms, communities, and processes is reviewed. The literature demonstrates that almost all stream communities, including microbial (bacterial, meiofaunal), macroinvertebrate, and fish communities are adversely affected by acidification. Fungal diversity may be enhanced at low pH; the effect of acidification on fungal activity is unclear. The biomass and productivity of epilithic algae and bryophytes appear to increase with declining pH in streams that are chronically acidic to a pH < 5 for extended periods. Benthic macroinvertebrate species richness and diversity and functional group richness show a consistent decline with decreasing pH. Streams with a pH < 5.5 generally have no fish, and reproduction of some species is impaired in streams with a pH < 6.0. (See also W91-07502) (Agostine-PTT)
W91-07506

EFFECTS OF ACIDIC PRECIPITATION ON LAKE ECOSYSTEMS.
Toronto Univ. (Ontario). Dept. of Zoology.
H. H. Harvey.
IN: Acidic Precipitation, Vol. 2: Biological and Ecological Effects. Advances in Environmental Science. Springer-Verlag New York, Inc., New York. 1989. p 137-164. 15 fig, 149 ref.

Descriptors: *Acid rain, *Acid rain effects, *Acidification, *Air pollution, *Ecosystems, *Lake acidification, *Lake ecology, *Limnology, Aluminum, Amphibians, Diatoms, Ecological effects, Fish, Hydrogen ion concentration, Lake restoration, Metals, Neutralization, Nitrates, Paleolimnology, Reviews, Sediment analysis, Snowmelt, Species diversity, Sulfates, Toxicity, Watersheds.

The acidification of surface waters has been demonstrated by direct observation of declining pH, reconstructions of historic pH values by means of sediment diatoms, and by declining alkalinity. The direct result of acidic deposition is cation depletion from sensitive watersheds. Anion composition shifts from bicarbonate to sulfate and nitrate, with the associated loss of buffering and increasing pH instability. At lower pH, metal recruitment from the watershed and mobilization from sediments is increased, resulting in higher concentrations in the water column. In acidifying waters, organisms are exposed to the toxicity of hydrogen ion and metals, especially monomeric aluminum. Episodic pH depressions induced by an acidic rain or snowmelt can bring about the death of fish, both larval and adult. Such losses result in the failure to recruit new age classes into the population or the juvenilization of the population. Amphibians are intolerant of low pH and are susceptible to acidic stress as larvae in meltwater ponds and stream pools. Fish-eating birds appear to suffer as acidification lessens their food supply, but birds feeding on invertebrates may benefit via reduced competition from fish. Many invertebrates are sensitive to hydrogen ion and are lost from lakes during acidification. This loss of invertebrate and fish diversity results in much simpler ecosystems, with more nutrients cycled through filamentous algae, moss, and fungi.

These adverse effects of acidification can be reversed at least in part by lake neutralization: a clear demonstration of the cause-effects relationship between acidic deposition and loss of the biota. (See also W91-07502) (Author's abstract)
W91-07507

EFFECTS OF ACIDIC PRECIPITATION ON FOREST ECOSYSTEMS IN NORTH AMERICA.
Yale Univ., New Haven, CT. School of Forestry and Environmental Studies.
W. H. Smith.
IN: Acidic Precipitation, Vol. 2: Biological and Ecological Effects. Advances in Environmental Science. Springer-Verlag New York, Inc., New York. 1989. p 165-188. 7 tab, 152 ref.

Descriptors: *Acid rain, *Acid rain effects, *Acidification, *Air pollution, *Forest ecosystems, *Global warming, *North America, Biomass, Environmental effects, Field tests, Plant growth, Population dynamics, Productivity, Species composition.

Forests are variable in species, topography, elevation, soils and management. Air pollution deposition and influences are also variable and poorly documented in the field. Monitoring of species dynamics and productivity, necessary to detect effects of regional and global air pollutants or any other environmental stress, are presently deficient. Regional contaminants may influence reproductive processes, nutrient uptake or retention, metabolic rates (especially photosynthesis and respiration), and insect pest and pathogen interactions of individual trees. At the ecosystem level, regional air pollutants may influence nutrient cycling, population dynamics of arthropod or microbial species, succession, species composition, and biomass production. In the case of low-dose regional-scale pollution, symptoms are typically not visible (at least initially), undramatic, and not easily measured. The integration of regional pollutant stresses can be slower growth, altered competitive abilities, and changed susceptibility to pests. Ecosystem symptoms may include altered rates of succession, changed species composition, and biomass production. Visible symptom expression is not a useful assessment strategy. The potential stresses imposed by regional-scale air pollutants must be viewed against the background of uncertainty associated with the changes in radiation balances from global-scale air contaminants. If global warming does accelerate in the near term, and especially if large forest regions are subjected to reduced moisture availability, the expansion of forest tree decline could be very great. Such an occurrence would pale the impact of regional-scale pollutant deposition. (See also W91-07502) (Author's abstract)
W91-07508

EFFECTS OF ACIDIC PRECIPITATION ON FOREST ECOSYSTEMS IN EUROPE.
Goettingen Univ. (Germany, F.R.). Abt. Bodenkunde und Waldernahrung.
B. Ulrich.
IN: Acidic Precipitation, Vol. 2: Biological and Ecological Effects. Advances in Environmental Science. Springer-Verlag New York, Inc., New York. 1989. p 189-272. 17 fig, 16 tab, 324 ref.

Descriptors: *Acid rain, *Acid rain effects, *Acidification, *Air pollution, *Europe, *Forest ecosystems, Aluminum, Biomass, Cations, Decomposition, Forest soils, Forests, Litter, Moisture stress, Nutrients, Ozone, Productivity, Reviews, Roots, Soil chemistry, Soil solution, Spruce trees, Subsoil, Topsoil.

The input-output relations of forest ecosystems in regard to acidity, heavy metals, and nutrients are discussed in relation to the buffering capacity and nutrient demand of the systems. During recent decades, acidity of forest soils has increased with a concomitant decrease in nutrient cation storage. There are indications that litter decomposition has been retarded. The direct effects of acidic deposition, SO2, NO3 and ozone on the leaves of trees well supplied with nutrients and water cannot explain the defoliation symptoms observed in German forests. A typical symptom seems to be damage in the vascular bundle caused by mineral deficiencies. Soil solution parameters characterizing proton and aluminum stress have been defined and tested in solution culture studies. Extensive field studies on the depth gradient of fine and coarse roots, on the dynamics of fine-root biomass and necromass, on damage symptoms of roots, on the elemental content of roots, and on the acidic stress parameters in the soil solution have been carried out. The results suggest that during recent decades the fine-root system has shifted to the topsoil as a consequence of the increased acidity in the subsoil. In the case of Norway spruce, this shift causes chronic water stress, which in turn causes crown thinning. Magnesium deficiency in Norway spruce, manifested as needle yellowing, can be attributed to the blockage of magnesium ion uptake by aluminum ions. (See also W91-07502) (Author's abstract)
W91-07509

EFFECTS OF ACIDIC PRECIPITATION ON THE BIOTA OF FRESHWATER LAKES.
Toronto Univ. (Ontario). Dept. of Botany.
P. M. Stokes, E. T. Howell, and G. Krantzberg.
IN: Acidic Precipitation, Vol. 2: Biological and Ecological Effects. Advances in Environmental Science. Springer-Verlag New York, Inc., New York. 1989. p 273-304. 5 tab, 125 ref.

Descriptors: *Acid rain, *Acid rain effects, *Acidification, *Air pollution, *Lake acidification, *Lake ecology, *Limnology, Aquatic life, Biomass, Dissolved organic carbon, Ecological effects, Ecosystems, Food chains, Hydrogen ion concentration, Macroinvertebrates, Productivity, Species diversity, Transparency, Water chemistry, Zooplankton.

The indirect effects of acidification are examined through changes in, for example, herbivore-plant and predator-prey balances. In general, the species richness of aquatic flora and fauna decreases with increasing H(+) concentration. Typically this is accompanied by an increase in the abundance and biomass of species that are quantitatively less significant in circumneutral lakes. Certain functional groups of macroinvertebrates, such as scrapers, may be more susceptible to changes in pH than others, such as shredders. With the exception of zooplankton, community biomass of plants and animals is not significantly affected by acidification, presumably because of the increased contribution of acid-tolerant species. Many potential biological effects are associated with acid-related chemical and physical changes that occur in aquatic systems; for example, decreases in dissolved organic carbon, changes in the speciation of inorganic carbon, mobilization and changes in speciation of metals, changes in phosphorus chemistry, and increased clarity of the water. (See also W91-07502) (Agostine-PTT)
W91-07510

EFFECTS OF ACIDIC PRECIPITATION ON SOIL MICROORGANISMS.
Brookhaven National Lab., Upton, NY. Dept. of Applied Science.
A. J. Francis.
IN: Acidic Precipitation, Vol. 2: Biological and Ecological Effects. Advances in Environmental Science. Springer-Verlag New York, Inc., New York. 1989. p 305-326. 117 ref. U.S. DOE Contract DE-AC02-76CH00016.

Descriptors: *Acid rain, *Acid rain effects, *Acidic soils, *Acidification, *Air pollution, *Microorganisms, *Soil organisms, Decomposing organic matter, Ecosystems, Environmental effects, Fate of pollutants, Nitrification, Nitrogen cycle, Pesticides, Respiration, Reviews, Soil chemistry, Species diversity.

Organic matter decomposition, soil respiration, and several steps in the nitrogen cycle are affected to varying degrees by and soil acidification and acidic rain. Variations in microbial activities reported in the literature are due largely to the complex properties of the different soil types studied, the diversity of the microbial community involved, the interdependence of various microbial processes, the experimental methodology used, and the duration of the experiments. Therefore, no generalizations can be made that are applicable to all ecosystems. Nevertheless, convincing evidence exists in the literature that acidic rain (1) affects soil microbial population and diversity; (2) retards organic matter transformation and possibly degradation of pesticides and other organic pollutants; and (3) affects certain steps in the nitrogen cycle, particularly nitrification. These effects could be long lasting and, in some instances, irreversible, and the responsible organisms eliminated altogether from the ecosystem. Many of the processes are interlinked and dependent on each other so that conclusions about one specific process in an ecosystem may be misleading. (See also W91-07502) (Agostine-PTT)
W91-07511

ALUMINUM TOXICITY AND TOLERANCE IN PLANTS.
Alberta Univ., Edmonton. Dept. of Botany.
G. J. Taylor.
IN: Acidic Precipitation, Vol. 2: Biological and Ecological Effects. Advances in Environmental Science. Springer-Verlag New York, Inc., New York. 1989. p 327-361. 8 fig, 263 ref.

Descriptors: *Acid rain, *Acid rain effects, *Acidification, *Air pollution, *Aluminum, *Phytotoxicity, *Plants, *Tolerance, *Toxicity, Acidic soils, Agriculture, Chelating agents, DNA, Ecological effects, Enzymes, Hydrogen ion concentration, Inhibition, Membrane processes, Metabolism, Phosphates, Plant growth, Proteins, Rhizosphere.

Acidic precipitation may affect vegetation as a result of increased mobility and phytotoxicity of Al in acidified soils. Soil acidity is a well known edaphic stress and a serious agricultural problem throughout large regions of the world. Not surprisingly, this has led to an intense research effort addressing the biology of Al stress. This research base provides a valuable resource for scientists investigating the impact of acidic precipitation on natural ecosystems. An overview of the literature dealing specifically with the physiological and biochemical mechanisms of Al phytotoxicity and tolerance of plants and plant communities is given. Review of the literature indicates that Al may have several direct toxic effects on plants. At the root-soil interface, potential effects include alterations in membrane structure and function and inhibition of membrane-bound enzymes. These effects may be the basis of Al-induced mineral deficiencies. Cell elongation may be reduced because of effects of Al on cell wall components or cell wall assembly. In the cytosol, Al appears to bind to phosphate in DNA, repressing template activity and inhibiting DNA synthesis. Toxic effects on enzyme-mediated reactions, especially in relation to phosphate metabolism and calcium-calmodulin are also likely. Aluminum tolerance appears to be a result of both exclusion and internal tolerance mechanisms. The plasma membrane and the cell wall likely play a role in exclusion of Al from the symplasm. Formation of a plant-induced pH barrier in the rhizosphere and exudation of chelate ligands may also contribute to this exclusion. In the symplasm, chelation in the cytosol by carboxylic acids or Al-binding proteins, compartmentation in the vacuole, and evolution of Al-tolerant enzymes are all of potential significance. (See also W91-07502) (Author's abstract)
W91-07512

ACIDIC PRECIPITATION, VOL. 3: SOURCES, DEPOSITION, AND CANOPY INTERACTIONS.
For primary bibliographic entry see Field 5B.
W91-07513

AEROSOL SULFUR ASSOCIATION WITH ALUMINUM IN EASTERN NORTH AMERICA: EVIDENCE FOR SOLUBILIZATION OF ATMOSPHERIC TRACE METALS BEFORE DEPOSITION.
Florida State Univ., Tallahassee. Dept. of Oceanography.
J. W. Winchester.
IN: Acidic Precipitation, Vol. 3: Sources, Deposi-

tion, and Canopy Interactions. Advances in Environmental Science. Springer-Verlag New York, Inc., New York. 1990. p 21-48. 5 fig, 12 tab, 26 ref. U.S. NSF Grant ATM 8601967.

Descriptors: *Acid rain, *Acid rain effects, *Acidification, *Aerosols, *Air pollution, *Aluminum, *Chemistry of precipitation, *Deposition, *North America, *Path of pollutants, *Sulfur, *Trace metals, *Water pollution sources, Atmosphere, Automotive industry, Industrial wastes, Lakes, Minerals, Soil chemistry, Solubility, Sulfur compounds.

Statistical evidence has been found for the association of atmospheric aerosol sulfur with soil mineral elements in the eastern United States. Evidence is presented based on analysis of existing aerosol composition data and reference to pertinent literature. The variability in time sequence aerosol composition, measured by proton-induced X-ray emission (PIXE) analysis of 3,600 two-hourly filter samples at nine sites during October 1977, has been examined using factor analysis and multiple linear regression. At all sites, 84-91% of the variance is accounted for by three or four factors, including a mainly sulfur component that also contains Al and other mineral metals, as well as one or two dust components and a Pb-Br component attributed to automotive emissions. The first of these is interpreted to represent sulfuric acid taken up by airborne alkaline mineral dust. At ambient relative humidities, sulfuric acid aerosol may reach pH 0 or below, and the alkaline soil mineral particles are expected to be rendered soluble by reaction with their strongly acidic surface coatings. The resulting solubilized trace metals, after wet or dry deposition to the surface may be more biologically available than if the metals were deposited in an insoluble mineral form. At two northeastern U.S. sites, the Al concentrations in the S-rich aerosol component are high enough to account for much of the soluble Al reported to be present in Adirondack lakes. At midwestern sites, the Al concentrations are higher, corresponding to the expected higher dust fluxes to the atmosphere by wind erosion of soils. At all sites, the atmospheric deposition fluxes of metals, after solubilization by reaction of airborne soil mineral particles with sulfuric acid, may be an important input to aquatic and possible terrestrial ecosystems. (See also W91-07513) (Author's abstract)
W91-07515

HISTORY OF ATMOSPHERIC DEPOSITION OF CD, HG, AND PB IN NORTH AMERICA: EVIDENCE FROM LAKE AND PEAT BOG SEDIMENTS.
Maine Univ. at Orono. Dept. of Geological Sciences.
S. A. Norton, P. J. Dillon, R. D. Evans, G. Mierle, and J. S. Kahl.
IN: Acidic Precipitation, V3: Sources, Deposition, and Canopy Interactions. Adv. in Env. Science. Springer-Verlag NY, Inc., NY. 1990. p 73-102. 10 fig, 3 tab, 144 ref. NSF Grants DEB-7922142, DEB7810641, US Dept. of the Interior Grants USOWRTAO48ME and RM-81-206GR, US Fish and Wildlife Serv. Gr. 1416000979040, US EPA Grant APP-0119-1982, US Forest Serv. Gr. 53-84M8-5-004, US DOE Grant 916597.

Descriptors: *Acid rain, *Acid rain effects, *Acidification, *Air pollution, *Cadmium, *Lake sediments, *Lead, *Mercury, *Paleolimnology, *Peat bogs, *Water pollution sources, Coal, Heavy metals, History, Industrial wastes, Reviews, Sediment chemistry.

The precipitation chemistry and lake and peat sediment chemistry of three metals emitted to the atmosphere in significant amounts as a result of anthropogenic activity are reviewed. The three metals, Cd, Hg, and Pb, have contrasting source terms, atmospheric residence times, and chemical mobility.Lake and ombrotrophic peat bog sediments record increases in the concentrations and accumulation rates of the metals for most of temperate North America for the last 100 years. These increases are largely related to the burning of coal, smelting of nonferrous metals, the transportation industry, and the industrial production of chlorine. Modern atmospheric fluxes of Cd in central North America are about 1000 times background fluxes; accumulation rates for Cd in sediments have increased two to 3 times above background, beginning about 100 years ago. Global scale Hg pollution of the atmosphere is suggested by concentrations in northern hemisphere air that are double the Hg content of southern hemisphere air. Accumulation rates of Hg in sediment have approximately doubled in the last 100 years. However, these rates are approximately an order of magnitude less than those for Cd. Modern increases in Pb concentrations are ubiquitous for all lakes examines thus far in North America. Input is from multiple sources and thus the timing of increased accumulation rates in sediment varies across the continent. Typical modern accumulation rates reach maxima at 20 to 30 mg/sq-m/yr, or 100 times that of Cd and 1,000 times that of Hg. Recent decreases in atmospheric lead are reflected in decreases in the accumulation rate of Pb in both lake and peat bog sediment in eastern North America. (See also W91-07513) (Author's abstract)
W91-07517

THROUGHFALL CHEMISTRY AND CANOPY PROCESSING MECHANISMS.
Syracuse Univ., NY. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2K.
W91-07518

EFFECT OF SOME POLLUTANTS ON SCE OF GRASS CARP (CTENOPHARYNGODON IDELLUS) CELLS (IN CHINESE).
Hangzhou Univ. (China).
S. J. Mao, and C. L. Wang.
Oceanologia et Limnologia Sinica (Hai Yang Yu Hu Chao) HYHCAG, Vol. 21, No. 3, p 205-211, 1990, 2 fig, 2 tab, 18 ref. English summary.

Descriptors: *Bioindicators, *Carp, *Mutagenicity, *Water pollution effects, Animal tissues, Fish, Liver, Metals, Stream pollution, Tissue analysis, Water quality.

The liver cells of one-year old juvenile grass carp (Ctenopharyngodon idellus) were exposed in vivo and in vitro to five metals and four pesticides which might be found in the environment of a river. Changes in sister chromatid exchange (SCE) were observed in the liver cells after exposure. A medium which contained 10.4 ng/ml of Cr(VI), 11.2 ng/ml of Cd(II), 7.49 ng/ml of As(III), 1 ng/ml of Hg(II), 20.7 microg/ml of Pb(II), or 21.6 microg/ml of Dipterex induced the SCE of cultured cells to increase. Breeding water which contained 1.5 microg/ml of Cr(VI), 1.5 microg/ml of Cd(II) or 1.3 microg/ml Hg(II) increased the SCE of in-vivo cells. Tricyluzole, Methamidophos and Carbofuran did not increase SCE. Because the grass carp is widespread and the methods of detecting SCE are simple and convenient. The grass carp could be used to monitor river pollution. (King-PTT)
W91-07533

EFFECTS OF HEAVY METALS ON EMBRYOS AND LARVAE OF FLAT FISH PARALICHTHYS OLIVACEUS (IN CHINESE).
Academia Sinica, Qingdao (China). Inst. of Oceanology.
Y. L. Wu, H. R. Zhao, and L. Y. Hou.
Oceanologia et Limnologia Sinica (Hai Yang Yu Hu Chao) HYHCAG, Vol. 21, No. 4, p 386-393, July 1990, 3 fig, 3 tab, 6 ref.

Descriptors: *Acute toxicity, *Flounders, *Heavy metals, *Teratogenicity, *Toxicology, *Water pollution effects, Cadmium, Chromium, Copper, Lead, Median tolerance limit, Zinc.

Embryos of the flatfish Paralichthys olivaceus were exposed to seawater containing concentrations of Cu (0.2-1.6 mg.L), Cd (2-16 mg/L), Pb (1-8 mg/L), Zn (8-16 mg/L), and Cr (10-80 mg/L). The embryos were exposed from 12 hours after fertilization (Germ ring stage) until hatching. The larvae were exposed to concentrations of Cu (0.2-1.6 mg/L), Cd (1-8 mg/L), Zn (2-16 ng/L), Pb (2-16 mg/L) and Cr (10-80 mg/L) for a period of 48 hours. The development of the embryos exposed to Cu, Zn, Cd had a significant decrease in hatchability and survival. Larvae exposed to Cu, Cd, Cr and Pb exhibited deformation. The 48 hours LC50 of heavy metals for embryos was Cu, 0.48; Zn, 6.55,; and Cd, 9.01 mg/L. The results indicated that fish embryos exhibited sensitivity to five metals : Cu (the highest), Zn, Cd, Pb, and Cr (the lowest). The 48 hour LC50 for heavy metals for larvae were Cu, 0.36; Cd, 2.0; Zn, 6.7; Pb, 8.0 ; and Cr, 62.3 mg/L. (Author's abstract)
W91-07538

EVALUATION OF THE DYNAMIC DAPHNIA TEST--EFFECT OF PESTICIDES ON THE SWIMMING BEHAVIOR OF DAPHNIA MAGNA UNDER LABORATORY AND FIELD CONDITIONS (ERFAHRUNGEN MIT DEM DYNAMISCHEN DAPHNIENTEST--EINFLUSS VON PESTIZIDEN AUF DAS SCHWIMMVERHALTEN VON DAPHNIA MAGNA UNTER LABOR- UND PRAXISBEDINGUNGEN).
Landesanstalt fuer Umweltschutz Baden-Wuerttemberg, Karlsruhe (Germany, F.R.).
U. Matthias, and H. Puzicha.
Zeitschrift fuer Wasser- und Abwasser-Forschung ZWABAQ, Vol. 23, No. 5, p 193-198, October 1990, 8 fig, 8 ref. English summary.

Descriptors: *Analytical methods, *Animal behavior, *Bioassay, *Bioindicators, *Dynamic Daphnia Test, *Pesticides, *Toxicology, Automation, Field tests, Laboratory methods, Performance evaluation, Water quality monitoring, Waterfleas.

Daphnidae show reproducible swimming activity when they are placed under standardized laboratory conditions. Upon the introduction of hazardous substances (e.g., pesticides), a significant change in swimming behavior can be observed. At first, a clear increase of swimming activity (hyperactivity) is observed; this is then followed by a gradual mobility decrease until death occurs. Using this procedure, which has been named the 'Dynamic Daphnia Test', clear and reproducible behavior is observed at concentrations over the acute toxicity range (effective concentration, or EC, values). An essential part of the Dynamic Daphnia Test is automated monitoring, which allows the detection of water-quality perturbations outside normal laboratory hours. (King-PTT)
W91-07545

ECOLOGICAL IMPACT OF URBAN STORMWATER RUNOFF STUDIED IN EXPERIMENTAL FLUMES: POPULATION LOSS BY DRIFT AND AVAILABILITY OF REFUGIAL SPACE.
Gesamthochschule Kassel (Germany, F.R.). Fachgebiet Siedlungswasserwirtschaft.
D. Borchardt, and B. Statzner.
Aquatic Sciences AQSCEA, Vol. 52, No. 4, p 299-314, 1990. 10 fig, 24 ref. LAWA (KFW) Grant No. K 9.2.

Descriptors: *Aquatic drift, *Aquatic habitats, *Aquatic populations, *Flumes, *Storm runoff, *Storm-overflow sewers, *Urban runoff, *Wastewater pollution, *Water pollution effects, Amphipods, Artificial watercourses, Channel morphology, Invertebrates, Laboratory methods, Population loss, Sewer systems, Storm water, Wastewater.

Urban stormwater runoff discharged through sewer systems into streams causes flush spills of water and pollutants in the receiving water. To make the right decisions in future planning of the very costly rehabilitation of sewer systems, a solid ecological data base on the critical parameters of sewer overflows is badly needed. A laboratory flume was therefore designed to be operated in circular flow mode to ensure adaptation of the test organism and in flow-through mode during the simulation of sewer overflows to allow a proper evaluation of population loss by drift. Experiments on behavior during the adaptation phase and population loss during exposure to flush spills of water and/or a mixture of sewage and clean water of a benthic invertebrate (Gammarus pulex) demonstrated the potential of the flume to identify critical

parameters of sewer overflows under quasi-real-world conditions. There was clear evidence for synergetic effects since the exposure to high flow and sewage caused higher population loss of Gammarus than the sum of population loss with exposure to only high flow or only sewage. Population loss considerably depended on the availability of refugial space; if the interstices of the gravel in the flume were silted, this loss was higher than with open interstices. Only 10 minutes of movement of the material forming the flume bottom reduced the population of Gammarus to about 60 or 50% of its initial size. Hence, it is strongly suggested that the characteristics of the receiving stream (refugial space, bed stability) play an important role in the potential ecological impact of a sewer overflow. Changes of stream morphology and/or creation of refugial space plus an appropriate technical solution for overflow treatment may be less costly and more effective than a large-scale construction project. The stream should itself be a major element in management decisions. (Author's abstract)
W91-07552

REDUCTION IN OOCYTE PRODUCTION AND GONADOTROPE ACTIVITY, AND PLASMA LEVELS OF ESTROGENS AND VITELLOGENIN, IN BROOK TROUT EXPOSED TO LOW ENVIRONMENTAL PH.

University of Western Ontario, London. Dept. of Zoology.
W. H. Tam, J. N. Fryer, B. Valentine, and R. J. J. Roy.
Canadian Journal of Zoology CJZOAG, Vol. 68, No. 12, p 2468-2476, December 1990. 7 fig, 39 ref.
Natural Sciences and Engineering Research Council of Canada Strategic Grants G1569 and G1784.

Descriptors: *Acid rain, *Acid rain effects, *Tissue analysis, *Toxicology, *Trout, *Water pollution effects, Acid stress, Acidification, Fish physiology, Hydrogen ion concentration, Hyperglycemia, Hyponatremia.

Maturing brook trout were exposed to pH 4.5 at the beginning of the rapid oocyte development phase in mid-June. The number of atretic follicles containing vitellogenic oocytes in acid-treated trout gradually increased with time, to exceed that of control fish on day 30, reaching a maximum (22-24% of all vitellogenic oocytes) between days 45 and 60 of acid exposure, before declining on day 73. Follicular atresia reduced the number of healthy vitellogenic oocytes in the acid-stressed fish to 59% of the controls by day 60. Plasma vittelogenin and estrogen levels were not consistently affected by acid exposure. During the first 45 days of acid exposure, the mean weight of the healthy vitellogenic oocytes and the plasma levels of estrogen in the acid-exposed fish were at times significantly higher than those of control trout, but after day 45 these differences were no longer observed. Ultrastructural morphometry showed that secretory activity of the gonadotropes in the female acid-stressed brook trout was suppressed. Throughout the experimental period, the acid-exposed trout showed various symptoms characteristic of acid stress, such as elevated ACTH and cortisol secretion, hyperglycemia, acidosis and hyponatremia. Food intake was reduced to 14% of the control value. These results suggest that the disruptive physiological changes and (or) reduced nutritional status associated with acid stress are responsible for the reduction in activity of the gonadotropes and oocyte atresia. (Author's abstract)
W91-07565

STREAM FISHES ESTIMATE WATER QUALITY IN DAYTON-MONTGOMERY COUNTY PARK DISTRICT RESERVES.

Miami Univ.-Middletown, OH. Dept. of Zoology.
For primary bibliographic entry see Field 5A.
W91-07571

TRIBUTYLTIN OXIDE INDUCED ALTERATIONS IN EXUVIAL WEIGHT AND CALCIUM CONTENT OF THE PRAWN, CARIDINA RAJADHARI.

Marathwada Univ., Aurangabad (India). Dept. of Zoology.
R. Nagabhushanam, P. S. Reddy, and R. Sarojini.
Proceedings of the Indian Academy of Sciences (Animal Sciences) PIANDR, Vol. 99, No. 5, p 397-400, 1990. 2 fig, 11 ref.

Descriptors: *Animal growth, *Antifoulants, *Organotin compounds, *River shrimp, *Toxicology, *Water pollution effects, Animal metabolism, Calcium resorption, Chitinolytic enzymes, Exoskeletal weight, Molt exuvia, Sublethal effects.

Molting is the most characteristic and important metabolic event in the life cycle of crustaceans. Cyclic cuticle deposition and resorption of calcium from old cuticle occur in relation to the crustacean molt cycle. The impact of sublethal concentrations of tributyltin oxide (TBTO) on exoskeletal weight and calcium on 3 successive molts of C. rajadhari was studied. Prolonged exposure of this prawn to media containing sublethal doses (0-015, 0-020, 0-025 and 0-040 ppm) of TBTO led to an increase in the dry weight exuvia and an increase in the total quantity of calcium. This increase was not significant in the initial two molts but it was significant ($p<0-01$) in the third molt when exposed to a minimum (0-015 ppm) dose. However, there was a significant ($p<0-01$) rise in both exuvial weight and calcium quantity in the first two molts and highly significant ($p<0-001$) in the third molt exuvia when exposed to maximum (0-040 ppm) dose. These observed exuvial changes from prawns exposed to TBTO might be due to a decrease in the resorption of the old cuticle and/or due to the inhibition of chitinolytic enzymes. (Author's abstract)
W91-07574

EFFECT OF HEAVY METAL SALTS ON THE LIFE HISTORY OF DAPHNIA SIMILIS CLAUS (CRUSTACEA: CLADOCERA).

Madurai-Kamaraj Univ. (India). School of Energy, Environment and Natural Resources.
S. Soundrapandian, and K. Ventkataraman.
Proceedings of the Indian Academy of Sciences (Animal Sciences) PIANDR, Vol. 99, No. 5, p 411-418, 1990. 5 fig, 4 tab, 14 ref.

Descriptors: *Acute toxicity, *Biomagnification, *Daphnia, *Heavy metals, *Toxicity, *Toxicology, *Water pollution effects, Body length, Fecundity, Longevity, Median tolerance limit, Molting frequency, Waterfleas.

The acute toxicity (LD-50) of heavy metal salts on D. similis was studied by observing changes in the longevity, body lenght, fecundity and molting frequency of this cladoceran. Copper was the most toxic and zinc the least. The decreasing order of toxicity on longevity, body length and fecundity was Zn > Pb > Cu > Hg, Cu > Zn > Hg > Pb and Pb > Cu > Zn > Hg, respectively. The average number of instars increased with the increase of the concentration of metals in the medium. The amount accumulated was Zn > Pb > Cu for 24 h and Zn > Cu > Pb for 48 h. Upon doubling the concentration of metal to which D. similis was exposed and feeding them to the fish Sarotherodon mossambicus, the biomagnification increased for copper and zinc while it decreased for lead. (Author's abstract)
W91-07575

ECOPHYSIOLOGICAL AND TROPHIC IMPLICATIONS OF LIGHT-STIMULATED AMINO ACID UTILIZATION IN MARINE PICOPLANKTON.

North Carolina Univ. at Chapel Hill. Inst. of Marine Sciences.
For primary bibliographic entry see Field 2L.
W91-07653

PHYTOPLANKTON SUCCESSION DURING ACIDIFICATION WITH AND WITHOUT INCREASING ALUMINUM LEVELS.

Kent State Univ., OH. Dept. of Biological Sciences.
K. E. Havens, and R. J. Heath.
Environmental Pollution ENPOEK, Vol. 68, No. 1/2, p 129-145, 1990, 6 fig, 1 tab, 34 ref.

Descriptors: *Acid rain, *Acid rain effects, *Acidification, *Aluminum, *Lake acidification, *Ohio, *Phytoplankton, *Succession, Algal growth, Algal toxins, Chlorophyta, Chrysophyta, Closterium, Desmids, Diatoms, East Twin Lake, Mesotrophic lakes, Peridinium, Species composition.

An in situ mesocosm experiment was performed to investigate the role of aluminum in controlling phytoplankton community succession during lake acidification. Large (2,000 liter) mesocosms were suspended in mesotrophic East Twin Lake, Ohio. Duplicates were either untreated controls (pH 8.8), acidified to pH 4.5 over 23 days, or acidified and spiked with 200 micrograms per liter Al in incremental additions. Filamentous blue greens, diatoms and other chrysophytes became extinct in both acid treatments, but declined most rapidly where Al levels were also increased. The large desmid Closterium and the filamentous chlorophyte Mougoetia became dominant in the acid treatment. In the Acid + Al treatment, these algae also became dominant, but the species with the greatest biomass was the dinoflagellate Peridium inconspicuum. Acidification (with or without added Al) also resulted in a significant shift in the algal size spectrum to larger (>20 micron) cells. Such a shift in size may explain the increase in transparency in the acidified mesocosms since larger cells attenuate less light. This condition favors algal growth. Despite an increase in algal growth, a decrease in zooplankton was also noticed since small herbivores are unable to graze on Peridinium. In acid lake communities dominated by inedible algae the major pathway for energy flow to higher trophic levels may be through the 'microbial loop' rather than the classical grazing food chain. (Doyle-PTT)
W91-07660

INFLUENCE OF APPLICATION RATE ON THE BACTERIAL MUTAGENICITY OF SOIL AMENDED WITH MUNICIPAL SEWAGE SLUDGE.

Texas A and M Univ., College Station. Dept. of Soil and Crop Sciences.
For primary bibliographic entry see Field 5E.
W91-07661

GLOBAL CLIMATE TRENDS AND GREENHOUSE GAS DATA: FEDERAL ACTIVITIES IN DATA COLLECTION, ARCHIVING, AND DISSEMINATION.

Department of Energy, Washington, DC. Office of Environmental Analysis.
Report to the Congress of the United States. Report No. DOE/PE-0094P, June 1990. 369p, 20 fig, 15 tab, 312 ref.

Descriptors: *Climatology, *Data storage and retrieval, *Databases, *Global warming, *Greenhouse effect, *Information exchange, *Water pollution sources, Air pollution, Data requirements, Economic aspects, Hydrocarbons, Information transfer, Methane, Nitrous oxide.

For the Energy and Water Development Appropriations Act, 1989, four studies on policy-related aspects of global climate change were requested. This report examines efforts of the US government to collect, manage, and disseminate data on the emissions of greenhouse gases, their atmospheric concentrations, and trends in the Earth's climate. It reviews how data are used to estimate and project emissions, to infer climate trends, and to support assessment and policy analysis functions, as well as its uses in scientific research. It examines coordination of Federal data activities among agencies. In addition to data needed for scientific research and identification of trends, this report considers the special data and information needs of government and the public for assessment and policy analysis purposes. The report concludes with recommendations which include: (1) that new mechanisms are needed to help integrate the existing Federal data management system by increasing communication, coordination, and exchange of data and information among data centers, data collectors, and users of global change data; (2) integrated databases and higher level information products are needed for assessment and policy analysis purposes; (3) certain

data centers have particularly critical needs for data maintenance that are not being met be current staff due to funding deficiencies; (4) data from international organizations and other countries is essential in studying global issues. The US global change network needs to provide access for US agencies and scientists to appropriate international data. World Data Centers should be more widely used and expanded where needed; (5) budgetary priorities should recognize the need for base levels of funding both for accession of new data and maintenance of continuity in existing conditions; (6) an effort is needed to convert historical maritime fleet records and land-based US climatic data to machine-readable formats; and (7) process measurements of several trace gases (e.g., nitrous oxide, methane, and other slow-reacting hydrocarbons) need to be made for the specific purposes of global climate change. (Lantz-PTT)
W91-07815

BIOACCUMULATION OF ZINC AND CADMIUM IN FRESHWATER ALGA, CHLORELLA VULGARIS. PART I. TOXICITY AND ACCUMULATION.
Kagoshima Univ. (Japan). Dept. of Applied Chemistry.
For primary bibliographic entry see Field 5B.
W91-07841

SIZE COMPOSITION AND ESTIMATED PHOSPHORUS REGENERATION RATES OF THE COPEPOD COMMUNITY ALONG AN ESTUARINE-OFFSHORE TRANSECT IN THE INLAND SEA OF JAPAN.
Hiroshima Univ. (Japan). Faculty of Applied Biological Science.
S. Uye, K. Imaizumi, and O. Matsuda.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 31, No. 6, p 851-863, December 1990. 7 fig, 26 ref.

Descriptors: *Copepods, *Estuarine environment, *Eutrophication, *Japan, *Osaka Bay, *Phosphates, *Phosphorus, *Water pollution effects, Biomass, Carbon, Excretion, Hydrography, Mesotrophy, Physiological ecology, Phytoplankton, Trophic level, Zooplankton.

Hydrographic data were obtained and water, phytoplankton, and zooplankton samples collected at 11 stations along a transect from the heavily eutrophified innermost part of Osaka Bay (Japan) to mesotrophic offshore shelf waters in Kii Channel in June and December 1985. In June, the copepod community consisted mainly of the small species Paracalanus sp. and Corycaeus spp. in the inner Osaka Bay, and was dominated by the large species Calanus sinicus in Kii Channel. In December, overall copepod biomass was lower than in June and the community consisted mainly of the small species Paracalanus sp. and Microsetella norvegica over the entire study area. From shipboard experiments, the phosphate excretion rate of a copepod was expressed as log E = 0.486 log W + 0.377, where E is excretion rate (ng P/individual/h) and W is copepod body carbon weight (micrograms C). Using this equation, the dissolved inorganic phosphorus (DIP) regeneration rate of the copepod community was estimated at each station, based on numerical abundance and size composition. Despite large geographical variations in ambient DIP concentration and uptake rate of the phytoplankton community, the DIP regeneration rate of the copepod community was relatively constant. The role of regenerated DIP was important at offshore stations in June when the DIP uptake rate of phytoplankton was high. (Author's abstract)
W91-07866

SEASONAL CHANGES IN SPECIES COMPOSITION AND PRODUCTION OF PERIPHYTON IN AN URBAN RIVER RUNNING THROUGH AN ABANDONED COPPER MINING REGION.
National Inst. for Environmental Studies, Tsukuba (Japan).
For primary bibliographic entry see Field 2H.
W91-07868

SEASONAL FLUCTUATION OF PHYTOPLANKTON WITH SPECIAL REFERENCE TO THE CHRYSOPHYTES IN FOUR PONDS AND LAKES SITUATED IN THE SOUTHERN PART OF HYOGO PREFECTURE, JAPAN.
Kobe City Water Works Bureau (Japan). Water Quality Lab.
For primary bibliographic entry see Field 2H.
W91-07873

ECOLOGICAL PROBLEMS OF THE THERMICS OF HYDROELECTRIC STATIONS.
A. G. Vasilevskii.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 3, p 167-172, 1990. 4 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 3, p 13-15, March, 1990.

Descriptors: *Dam effects, *Hydroelectric plants, *Reservoirs, *Soviet Union, *Temperature effects, *Thermal pollution, *Water pollution effects, Air pollution, Design criteria, Enisei River, Fog, Hypolimnion, Krasnoyarsk Hydroelectric Plant, Microclimate, Recreation, Seasonal variation.

The Krasnoyarsk hydrostation is a clear example shedding light on the entire gamut of problems of operating a hydrostation after the water temperature in the pools has changed. In the summer, water withdrawn from the unheated layers of the reservoir has a temperature 5-10 C lower than the natural water, making the water of the Enisei River as it passes through Krasnoyarsk unsuitable for recreation. In the winter, the lack of an ice cover on the river results in fog formation, with together with emissions in the atmosphere from fuel combustion and wastes of the chemical industry considerably worsens the local microclimate. A detailed study of the thermal regime of the Krasnoyarsk hydrostation is currently in progress. It is concluded from this case that thermal forecasts should be developed at an early stage of designing a hydrostation and should be taken into account when selecting the site of structures, capacity, and operating regime of the hydrostation. (Rochester-PTT)
W91-07878

WATER AND SALT REGIME OF THE ARNASAI LAKES.
For primary bibliographic entry see Field 6G.
W91-07879

INFLUENCE OF LIGHT AND TEMPERATURE ON THE GROWTH OF FOUR ALGAE FROM A EUTROPHIC LAKE (LAKE AYDAT, PUY DE DOME, FRANCE) (INFLUENCE DE LA LUMIERE ET DE LA TEMPERATURE SUR LA CROISSANCE DE QUATRE ESPECES D'ALGUES D'UN LAC EUTROPHE (LAC AYDAT, PUY DE DOME, FRANCE)).
Clermont-Ferrand-2 Univ., Aubiere (France). Lab. de Zoologie et Protistologie.
For primary bibliographic entry see Field 2H.
W91-07982

BIG RIVER, CO LOUTH, IRELAND: A CASE STUDY IN RECOVERY.
Dundalk Regional Technical Coll. (Ireland). Dept. of Experimental Sciences.
For primary bibliographic entry see Field 5G.
W91-07984

UREASE-AGAR-DIFFUSION-TEST FOR RAPID DETERMINATION OF THE TOXICITY OF SURFACE WATERS (DER UREASE-AGAR-DIFFUSIONSTEST ZUR SCHNELLEN TOXIZITAETSBESTIMMUNG VON OBERFLAECHENGEWAESSERN).
Universitaet des Saarlandes, Homburg/Saar (Germany, F.R.). Medizinische Fakultaet.
For primary bibliographic entry see Field 5A.
W91-07990

ACUTE GIARDIASIS: AN IMPROVED CLINICAL CASE DEFINITION FOR EPIDEMIOLOGIC STUDIES.
Colorado Dept. of Health, Denver. Disease Control and Epidemiology Div.
R. S. Hopkins, and D. D. Juranek.
American Journal of Epidemiology AJEPAS, Vol. 133, No. 4, p 402-407, February 15, 1991. 1 fig, 2 tab, 6 ref.

Descriptors: *Epidemiology, *Human diseases, *Public health, *Water pollution effects, Case studies, Colorado, Epidemics, Giardia, Giardiasis, Infection.

In June 1983, an outbreak of waterborne giardiasis occurred in a group of 93 university students and faculty participating in a geology field course in Colorado. All cases occurred in one subgroup of persons who were heavily exposed to untreated stream water on a field trip, and the risk of illness was strongly related to the amount of untreated stream water consumed. The median incubation period from a brief exposure to the first symptom was 7 days. Symptoms and stool sample results were compared among 31 Giardia-positive persons in the exposed group and 36 Giardia-negative participants in an unexposed group to assess several case definitions for acute giardiasis. A giardiasis case definition of 5 days or more of diarrhea, the definition used in many epidemiologic studies of giardiasis, had a specificity of 100% but a sensitivity of only 32.2% compared with a definition based on results of stool examinations. When a case was defined as an illness lasting 7 days or more, with a combination of two or more of six symptoms (diarrhea, flatulence, foul-smelling stools, nausea, abdominal cramps, and excessive tiredness), sensitivity rose to 73%, with a specificity of 88%. Such a case definition may be an improvement over that of 5 days of diarrhea, especially in outbreaks where there is good laboratory documentation that Giardia is the etiologic agent. The definition should be validated in other outbreaks and in situations where giardiasis must be distinguished from gastrointestinal disease caused by other agents. (Author's abstract)
W91-07995

TOXICITY OF MICROENCAPSULATED PERMETHRIN TO SELECTED NONTARGET AQUATIC INVERTEBRATES.
Guelph Univ. (Ontario). Dept. of Environmental Biology.
P. K. Sibley, and N. K. Kaushik.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 20, No. 2, p 168-176, February 1991. 6 fig, 3 tab, 44 ref.

Descriptors: *Bioassay, *Invertebrates, *Pesticides, *Toxicity, *Water pollution effects, Acute toxicity, Chronic toxicity, Daphnia, Lethal limit, Microencapsulation, Permethrins, Pesticide toxicity, Pyrethroids.

Microencapsulated permethrin (penncapthrin) was evaluated under laboratory conditions for its toxicity toward several nontarget aquatic invertebrates. Average LC50 estimates for selected lotic invertebrates, based on a one hour dosing regime, were: 2.71 mg/L for Simulium vittatum, 4.59 mg/L for Hydropsyche spp., and 13.41 mg/L for Isonychia bicolor. In acute static tests with Daphnia magna, there was no significant difference between the toxicity of penncapthrin at 96 h (LC50 range: 6.80-22.5 microg/L) and the EC formulation (LC50 range: 0.6-21 microg/L). Comparatively, the toxicity of microencapsulated methyl parathion (penncap-m) was not significantly different from that of penncapthrin toward D. magna. LC50 estimates associated with D. pulex ranged from 19 to 131 microg/L. The toxicity of penncapthrin and penncap-m toward D. pulex was difficult to determine because of frequent control mortality due to food deprivation resulting from the need to run tests for longer than 48 h. In successful tests, LC50 estimates ranged from 19 to 28 microg/L for penncapthrin and from 0.08 to 25 microg/L for penncap-m after 72 h exposure. In long term toxicity tests (39 d), survival of D. magna was 95%, 44%, and 20% at 1, 10 and 15 microg/L penncapthrin, respectively. Less than 15% of D. pulex survived over the same concentration range following 32 d exposure. Despite some drawbacks, long-term tox-

icity tests were more appropriate than short-term test for evaluating microencapsulated pesticides because of reduced variability in LC50 estimates and lower control mortality. (Author's abstract)
W91-07998

IMPACT OF FURADAN 3G (CARBOFURAN) APPLICATIONS ON AQUATIC MACROINVERTEBRATES IN IRRIGATED RICE IN SENEGAL.
Agricultural Univ., Wageningen (Netherlands). Dept. of Toxicology.
W. C. Mullie, P. J. Verwey, A. G. Berends, F. Sene, and J. H. Koeman.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 20, No. 2, p 177-182, February 1991. 3 fig, 2 tab, 19 ref.

Descriptors: *Agricultural chemicals, *Aquatic life, *Carbofuran, *Pesticide toxicity, *Pesticides, *Rice fields, *Water pollution effects, Bioindicators, Environmental effects, Macroinvertebrates, Rice, Senegal, Water birds.

The impact of Furadan 3G applications (carbofuran, granular formulation; dose rate 1 kg a.i./ha) on aquatic macroinvertebrates was studied in irrigated test plots with rice in northern Senegal. Total biomass of macroinvertebrates and numbers of Ordonata, Ephemeroptera, Nematocera (Diptera), and Hydrocorisae (Hemiptera) were severely and significantly reduced after treatment, and remained significantly lower than those in control plots until at least 24 days after treatment. No effects could be demonstrated on Veliidae (Hemiptera), Coleoptera, and Arachnida. In an in situ bioassay, Ephemeroptera was the most sensitive taxon, showing 50% mortality at 18-19 days after treatment. Side-effects of carbofuran applications were also observed in frogs and birds; some birds that consumed spilled granules died immediately. Furadan 3G applications, as practiced in the region, cause dramatic effects on many nontarget organisms. Its use is hazardous to wildlife, and it severely reduces the significance of irrigated rice fields as a feeding habitat for birds, including waders, and other insectivorous organisms. (Author's abstract)
W91-07999

SENSITIVITY OF CERIODAPHNIA DUBIA AND DAPHNIA MAGNA TO SEVEN CHEMICALS UTILIZING THE THREE-BROOD TEST.
Dow Chemical Co., Midland, MI. Environmental Toxicology and Chemistry Research Lab.
For primary bibliographic entry see Field 5A.
W91-08001

INFLUENCE OF ALUMINUM AND H+ ON THE ELECTROLYTE HOMEOSTASIS IN THE UNIONIDAE ANODONTA ANATINA L. AND UNIO PICTORUM L.
Utrecht Rijksuniversiteit (Netherlands). Research Group for Aquatic Toxicology.
K. Pynnonen.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 20, No. 2, p 218-225, February 1991. 5 fig, 2 tab, 29 ref.

Descriptors: *Acid rain effects, *Acidic water, *Aluminum, *Electrolytes, *Shellfish, *Water pollution effects, Acidity, Animal physiology, Calcium, Clams, Freshwater, Hardness, Hemolymph, Homeostasis.

Two species of freshwater clams, Anodonta anatina and Unio pictorum, were exposed to aluminum (300-900 microg/L) and acid (pH 4-5 and pH 6.6-8.3) in hard (35 mg/L Ca) and soft (3.5 mg/L Ca) water. Long-term and short-term pH depressions of 2 and 3 weeks and intermittent, repetitive pulses of 3 days were used. The pattern of change in the hemolymph electrolyte balance was different in U. pictorum and in A. anatina. In general, an increase in hemolymph Ca(2+), and a decrease in Na(+), Cl(-), K(+), and Mg(2+) as a result of acid exposure was seen in both species. Hemolymph Ca(2+) of U. pictorum was increased after 3 days of exposure to acid water, whereas an exposure of one week was needed to affect the other hemolymph ions. In circum-neutral, hard water Al had no effect on the electrolyte balance. Intermittent pulses of low pH and Al produced a transitory increase in hemolymph Ca(2+), whereas Na(+) and K(+) were not affected. (Author's abstract)
W91-08002

TOXIC ELEMENT CONTAMINATION AND THE OCCURRENCE OF MERCURY-RESISTANT BACTERIA IN HG-CONTAMINATED SOIL, SEDIMENTS, AND SLUDGES.
California Univ., Irvine.
For primary bibliographic entry see Field 5B.
W91-08003

PROTECTION OF INVERTEBRATES, FISH, AND VASCULAR PLANTS AGAINST INORGANIC MERCURY POISONING BY SULFUR AND SELENIUM DERIVATIVES.
Hawaii Univ. at Manoa, Honolulu. Dept. of Botany.
B. Z. Siegel, S. M. Siegel, T. Correa, C. Dagan, and G. Galvez.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 20, No. 2, p 241-246, February 1991. 1 fig, 4 tab, 20 ref. NIH Grants RR08125-09 to RR08125-15.

Descriptors: *Fish, *Invertebrates, *Mercury, *Plants, *Selenium, *Toxicity, *Toxicology, *Water pollution effects, Heavy metals, Poisons, Thiamine, Toxic metals.

Protection of organisms against mercury (Hg) poisoning is most commonly associated with the antagonistic effects of selenium (Se)-compounds against mercury alkyls in higher animals. No consistent difference was found among Periodic Group VIA derivatives including S(IV), S(II) organic, Se(IV), Se(II) organic, possibly Se(VI), as well as Te(IV) in their ability to protect against mercury poisoning. The organisms used in assays were: Coleus explants (leaf abscission); turnip (germination); pea (growth inhibition and Hg uptake); a planarian (regeneration); the brine shrimp (excystment, phototaxy); the meal worm larva Tenebrio (metamorphosis) and the fish 'tilapia' (survival, Hg uptake). Thiamine was the most effective of the Group VIA derivatives against the widest spectrum of organisms and test systems. In planarian regeneration, it was active where S and Se compounds failed. An unexpected observation was the hastening of insect metamorphosis by mercuric chloride and the hastening of that effect by thiamine. (Author's abstract)
W91-08004

EFFECTS OF METALS ON EARLY LIFE STAGES OF THE BRINE SHRIMP, ARTEMIA: A DEVELOPMENTAL TOXICITY ASSAY.
Dalhousie Univ., Halifax (Nova Scotia). Dept. of Biology.
For primary bibliographic entry see Field 5A.
W91-08005

ANOXIC SURVIVAL TIME AND METABOLIC PARAMETERS AS STRESS INDICES IN SEA MUSSELS EXPOSED TO CADMIUM OR POLYCHLORINATED BIPHENYLS.
Utrecht Rijksuniversiteit (Netherlands). Dept. of Experimental Zoology.
M. B. Veldhuizen-Tsoerkan, D. A. Holwerda, and D. I. Zandee.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 20, No. 2, p 259-265, February 1991. 6 fig, 1 tab, 31 ref.

Descriptors: *Cadmium, *Coastal waters, *Mussels, *Polychlorinated biphenyls, *Toxicity, *Water pollution effects, Anoxia, Anoxic conditions, Heavy metals, Lethal limit, Stress indices, Survival.

Sea mussels, Mytilus edulis, were exposed to cadmium under laboratory and semi-field conditions and to polychlorinated biphenyls (PCBs) under semi-field conditions. After various exposure times, the animals were subjected to environmental anoxia by aerial exposure. The anoxic survival time was significantly reduced by short-term laboratory or semi-field exposure to cadmium. The effect of PCBs on the anoxic survival time was apparent after six months. Condition indices, adenylate energy charge, and glycogen contents were not significantly altered in response to long-term semi-field exposure to cadmium or PCBs. An elevated succinate level observed in both cadmium-exposed and PCB-exposed groups might reflect a partial switch to anaerobic metabolism upon exposure to these pollutants. It is concluded that measurement of anoxic survival time in M. edulis may be useful in examining the noxious effects of environmental pollutants. (MacKeen-PTT)
W91-08007

TOXIC ACTION AND INTERACTIONS OF COPPER AND CADMIUM TO THE MARINE ALGA DUNALIELLA MINUTA, IN BOTH ACUTE AND CHRONIC EXPOSURE.
Herbert H. Lehman Coll., Bronx, NY. Dept. of Biological Sciences.
I. Visviki, and J. W. Rachlin.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 20, No. 2, p 271-275, February 1991. 2 tab, 40 ref. PSC-CUNY Grant 669185, NIH Grant GRS 3SO 6 RRO 8225/05 S2/442-664.

Descriptors: *Algae, *Cadmium, *Copper, *Heavy metals, *Toxicity, *Toxicology, *Water pollution effects, Acute toxicity, Chronic toxicity, Marine algae, Population dynamics, Tolerance.

The effective concentrations of copper and cadmium which reduced the population growth of Dunaliella minuta by 50% after 96 h of static exposure were determined to be 7.57 microM Cu and 0.34 microM Cd. Short-term, static exposure to both metals indicated that their combined action is antagonistic with respect to growth of this chlorophyte. Low level, long term exposure of D. minuta to Cd also led to Cu co-tolerance. However, co-tolerance towards Cd did not develop in Cu pretreated populations. This confirms that tolerance to one heavy metal does not directly confer co-tolerance to others. (MacKeen-PTT)
W91-08008

FIELD STUDY OF THE IMPACT ON OYSTERS OF TRIBUTYLTIN INTRODUCTION AND REMOVAL IN A PRISTINE LAKE.
Sydney Univ. (Australia). Inst. of Marine Ecology.
M. S. Scammell, G. E. Batley, and C. I. Brockbank.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 20, No. 2, p 276-281, February 1991. 4 fig, 4 tab, 10 ref.

Descriptors: *Antifoulants, *Australia, *Bivalves, *Lakes, *Toxicity, *Water pollution effects, Bioaccumulation, Boating, Degradation products, Field tests, Lake Wapengo, Organotin compounds, Oysters.

In a pristine lake (Wapengo Lake, on the New South Wales coast of Australia) the impacts on the Sydney Rock oyster Saccostrea commercialis of the introduction and removal one month later of two boats antifouled with a tributyltin (TBT)-based paint were examined. A three-factor analysis of variance showed that the presence of shell curls in oysters was significant in the area closest to the boats and the contaminant source was restricted from migration to leases on the other side of the channel perhaps by a 3-m deep channel that may act as a natural barrier. A good correlation between shell deformities and TBT accumulation was obtained. Significant TBT accumulation occurred within the brief exposure of young oysters; however, an analysis of the distribution of butlytins before and after removal of the boats suggested that the oysters were responding to degradation products in the water rather than promoting in vivo degradation. (Author's abstract)
W91-08009

TOXICITY OF WATERBORNE BORON TO DAPHNIA MAGNA AND CHIRONOMUS DE-

CORUS AND THE EFFECTS OF WATER HARDNESS AND SULFATE ON BORON TOXICITY.
California Univ., Davis. Dept. of Land, Air and Water Resources.
K. J. Maier, and A. W. Knight.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 20, No. 2, p 282-287, February 1991. 2 fig, 3 tab, 32 ref. U.S. Geological Survey Grant 14-08-0001-G1495.

Descriptors: *Boron, *Macroinvertebrates, *Toxicity, *Water pollution effects, Acute toxicity, Aquatic insects, Bioindicators, Chronic toxicity, Daphnia, Growth rates, Hardness, Lethal limit, Sulfates, Waterfleas.

The concentrations of many elements, including boron, are increasing in aquatic ecosystems due to anthropogenic activities. Laboratory studies were undertaken to evaluate the toxicity of waterborne boron to two key freshwater macroinvertebrates and to evaluate the effects of water hardness and sulfate on boron toxicity. Acute toxicity evaluations of waterborne sodium tetraborate resulted in 48 h LC50 values of 141 and 1376 mg B/L for neonate Daphnia magna and fourth instar Chironomus decorus, respectively. Chronic sublethal studies demonstrated a significant decrease in C. decorus growth rate at 20 mg B/L. Further studies showed that increasing water hardness (10.6 to 170 mg/L as calcium carbonate) and sulfate (10.2 to 325.4 mg/L sulfate) concentrations did not affect boron toxicity to D. magna. These results, in conjunction with a review of the literature, suggest that aquatic macrophytes may be more sensitive to boron than macroinvertebrates and thus would be better choices for aquatic risk assessment evaluations for this element. (Author's abstract)
W91-08010

INTERACTIVE EFFECTS OF BORON, SELENIUM, AND DIETARY PROTEIN ON SURVIVAL, GROWTH, AND PHYSIOLOGY IN MALLARD DUCKLINGS.
Patuxent Wildlife Research Center, Laurel, MD.
D. J. Hoffman, C. J. Sanderson, L. J. LeCaptain, E. Cromartie, and G. W. Pendleton.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 20, No. 2, p 288-294, February 1991. 4 tab, 35 ref. U.S. Bureau of Reclamation/U.S. Fish and Wildlife Service Interagency Agreement 60AA-20-04170.

Descriptors: *Boron, *Diets, *Drainage water, *Ducks, *Selenium, *Toxicity, *Water birds, *Water pollution effects, Animal physiology, Bioaccumulation, Dietary protein, Growth rates, Irrigation effects, Lethal limit, Survival.

High concentrations of boron (B) and selenium (Se) have been found in aquatic food chains associated with irrigation drainwater. Total biomass of invertebrates, a major source of protein for wild ducklings, is sometimes diminished in agricultural drainwater ponds contaminated with Se and B. Day-old mallard (Anas platyrhynchos) ducklings received an untreated diet (controls) containing 7 or 22% protein or diets containing various combinations Se (15 or 60 ppm) and B (1000 ppm) for four weeks. With 22% protein and 60 ppm Se in the diet, duckling survival and growth were reduced and histopathological lesions of the liver occurred. Boron alone caused some reduction in growth. Several interactive effects occurred between B and Se, including further reduction in growth, and increases in plasma glutathione reductase activity, hematocrit, hemoglobin and plasma protein concentrations. With 7% protein, the growth of controls was less than that with 22% protein, 60 ppm Se caused 100% mortality, and growth effects of 15 ppm Se and 1000 ppm B alone were more pronounced than with 22% protein. Selenium accumulation increased in the liver with 7% protein. Interactive effects were greater for Se and B with 7% protein than with 22% protein and included significant mortality and enhanced accumulation of Se in the liver. These finding suggest the potential for more severe toxicological effects of Se and B independently and interactively on duckling survival and development when dietary protein is diminished. (Author's abstract)
W91-08011

PRODUCTION, NUTRIENT DYNAMICS AND INITIAL DECOMPOSITION OF FLOATING LEAVES OF NYMPHAEA ALBA L. AND NUPHAR LUTEA (L.) SM. (NYMPHAEACEAE) IN ALKALINE AND ACID WATERS.
Katholieke Univ. Nijmegen (Netherlands). Lab. of Aquatic Ecology.
For primary bibliographic entry see Field 2H.
W91-08012

EFFECTS OF DIFLUBENZURON AND METHOPRENE ON THE EMERGENCE OF INSECTS AND THEIR DENSITY IN AN OUTDOOR EXPERIMENTAL STREAM.
National Inst. for Environmental Studies, Tsukuba (Japan).
M. Yasuno, and K. Satake.
Chemosphere CMSHAF, Vol. 21, No. 10/11, p 1321-1335, 1990. 5 fig, 2 tab, 12 ref.

Descriptors: *Aquatic insects, *Benthic fauna, *Insecticides, *Water pollution effects, Benthic environment, Diflubenzuron, Larvae, Methoprene, Streams.

Benthic communities in outdoor experimental streams were exposed to 1 and 10 mg/L of diflubenzuron and the same concentrations of methoprene for 30 min. The effects of these chemicals were assessed daily by examining drifting pupal exuviae over a period of one month following the treatment. Neither chemical induced the drift of macrobenthos at the time of application. However, diflubenzuron affected the emergence of all species examined. A high larval mortality of a species of chironomid was observed directly in the stream treated with diflubenzuron, where mayfly nymphs and caddisfly larvae were also decreased. However, in the stream treated with methoprene, no marked mortality of benthos could be observed, but chironomids and caddisflies disappeared. The adult emergence of the mayfly, Baetis sahoensis, in the region treated with 1 mg methoprene/L was similar to that in controls; and in the region treated with 10 mg/L the emergence rate exceeded 50% on the 16th day, which was higher than that in the control. (MacKeen-PTT)
W91-08023

EXPERIMENTAL LEAD NITRATE POISONING: MICROSCOPIC AND ULTRASTRUCTURAL STUDY OF THE GILLS OF TENCH (TINCA TINCA, L).
Department of Histology and Pathological Anatomy, Faculty of Veterinary Sciences, Caceres, Spain.
V. Roncero, J. A. Vincente, E. Redondo, A. Gazquez, and E. Duran.
Environmental Health Perspectives EVHPAZ, Vol. 89, p 137-144, November 1990. 19 fig, 3 tab, 26 ref.

Descriptors: *Fish pathology, *Lead, *Nitrates, *Toxicity, *Toxicology, *Water pollution effects, Acute toxicity, Cyprind fishes, Dose-response relationships, Gills, Microscopic analysis, Mortality.

A microscopic, ultrastructural, and morphometric study was made of the gills of Tench (Tinca tinca, L.) subjected to acute experimental lead nitrate poisoning. Twenty-one adult tench were subjected to poisoning and a further 22 were used as controls. Lesions were characterized by the appearance of edema and epithelial hyperplasia and necrosis, both in cells forming part of the filtration barrier and in those in the interlamellar space. These processes developed 24 to 48 h after administration of the lead nitrate and were completely developed after 9 days, leading to the death of the tench after 12 to 15 days of exposure to 75 ppm lead nitrate, at which point the concentrations of lead in the gills had reached their maximum. The severity of lesions to the gill increased with increasing lead accumulation, although not proportionately. (Author's abstract)
W91-08024

EFFECTS OF ACID PRECIPITATION RUNOFF EPISODES ON RESERVOIR AND TAPWATER QUALITY IN AN APPALACHIAN MOUNTAIN WATER SUPPLY.
Pennsylvania State Univ., University Park. Environmental Resources Research Inst.
For primary bibliographic entry see Field 5B.
W91-08025

CONSISTENT ASSOCIATIONS BETWEEN HEPATIC LESIONS IN ENGLISH SOLE (PAROPHRYS VETULUS) AND POLYCYCLIC AROMATIC HYDROCARBONS IN BOTTOM SEDIMENT.
National Marine Fisheries Service, Seattle, WA. Northwest Fisheries Center.
J. T. Landahl, B. B. McCain, M. S. Myers, L. D. Rhodes, and D. W. Brown.
Environmental Health Perspectives EVHPAZ, Vol. 89, p 195-203, November 1990. 2 fig, 4 tab, 39 ref. Department of Health and Human Services Y01-CP-40507.

Descriptors: *Estuarine sediments, *Fish pathology, *Polycyclic aromatic hydrocarbons, *Sediment contamination, *Sole, *Toxicology, *Water pollution effects, Bottom sediments, Hepatic lesions, Hydrocarbons, Marine sediments, Neoplasms, Puget Sound, Statistical analysis, Washington.

A consistent and statistically significant association between prevalence of hepatic neoplasms in free-living sole (Parophrys vetulus) and levels of anthropogenic polycyclic aromatic hydrocarbons in bottom sediment from sites of fish capture was documented in a series of studies conducted over a period of 7 years in Puget Sound, Washington. This result strengthens the evidence supporting a causal relationship between exposure to sediment-associated hydrocarbons and development of hepatic neoplasms in this bottom-dwelling marine fish species. Prevalences of two other distinct categories of idiopathic hepatic lesions, megalocytic hepatosis and steatosis/hemosiderosis, also showed consistent, statistically significant associations with polycyclic aromatic hydrocarbon concentrations in bottom sediment, and association with prevalence of a third category (putatively preneoplastic foci of cellular alteration) approached statistical significance. On the basis of other studies, megalocytic hepatosis and foci of cellular alteration are both considered to be important precursor lesions in the stepwise histogenesis of hepatic neoplasms. (Author's abstract)
W91-08026

MARINE POLLUTION BIOASSAY BY SEA URCHIN EGGS, AN ATTEMPT TO ENHANCE SENSITIVITY.
Doshisha Univ., Kyoto (Japan). Biological Lab.
For primary bibliographic entry see Field 5A.
W91-08044

TOXICITY, BIOACCUMULATION, METABOLISM AND ELIMINATION OF DIOCTYL SODIUM SULFOSUCCINATE DSS IN RAINBOW TROUT (ONCORHYNCHUS MYKISS).
NIEHS Marine and Freshwater Biomedical Core Center, Milwaukee, WI.
For primary bibliographic entry see Field 5B.
W91-08045

BIODEGRADATION AND ANTICHOLINESTERASE ACTIVITY OF METHYL ISOCYANATE IN THE AQUATIC ENVIRONMENT OF BHOPAL.
National Inst. of Oceanography, Panaji (India).
R. Sen Gupta, A. Sarkar, and T. W. Kureishy.
Water Research WATRAG, Vol. 25, No. 2, p 179-183, February 1991. 1 fig, 4 tab, 7 ref.

Descriptors: *Bhopal, *Bioaccumulation, *Biodegradation, *Enzymes, *Fate of pollutants, *India, *Methyl isocyanate, *Water pollution effects, Ammonia, Anticholinesterase, Eutrophication, Fish, Hydrogen ion concentration, Lakes, Nitrogen, Tissue analysis, Ureas.

A study of the biodegradation of methyl isocyanate (MIC) and its anticholinesterase activities in different tissues of various species of fish from the lakes of Bhopal (India) was carried out over a period of 6 months with bimonthly observations. The concentration of the degradation product of MIC, monomethylamine, in the water of both the lakes of Bhopal was estimated. On each occasion it was found to indicate a decreasing trend. However, a depth-wise increase of concentration of monomethylamine was observed in the Lower Lake. Bioaccumulation of monomethylamine was also estimated in different tissues of various species of fish collected from the Upper and Lower Lakes of Bhopal and from Aligarh. Among all the species available in Lower Lake, Puntius ticto was found to be most susceptible to MIC poisoning. There is a change in the values of pH, ammonia nitrogen, and urea nitrogen concentrations in Lower Lake. The cholinesterase activities of different tissues of various species of fish from the lakes of Bhopal were found to be quite low compared to that of fish from the uncontaminated lake of Aligarh, indicating the anticholinesterase activity of MIC. It is concluded that while the Upper Lake appears to have recovered from the effects of MIC, the Lower Lake is completely eutrophic and can be considered dead. (Author's abstract)
W91-08052

EFFECT OF HEAVY METALS ON SHORT-TERM PHOTOSYNTHETIC RATES IN POTAMOGETON AMPLIFOLIUS.
Oral Roberts Univ., Tulsa, OK. Dept. of Biology.
M. R. Porter, and D. A. Francko.
Journal of Aquatic Plant Management JAPMDB, Vol. 29, p 51-53, January 1991. 1 fig, 9 ref. NSF Grant DIR-8900456.

Descriptors: *Aquatic plants, *Bioassay, *Heavy metals, *Photosynthesis, *Plant physiology, *Pondweeds, *Water pollution effects, Chromium, Copper, Leaves, Littoral environment, Metabolism, Pollutant identification.

A leaf disk bioassay method was used to conduct a preliminary analysis of the effect of short-term (15 min to 4 h) chromium and copper exposure on photosynthetic C14-assimilation (PCA) rates in the pondweed Potamogeton amplifolius. Results suggest that the Potamogeton leaf disk bioassay method is relatively insensitive to chromium levels in the medium. Although low levels of chromium addition produced reproducible reductions in PCA rates during the shortest incubation period used, inhibition did not appear to be dose-specific and in no case was an EC-50 concentration detectable. Thus, while the effects on PCA rates may be ecologically significant in littoral waters containing chromium contamination, the data argue against the utility of this method as a metal-detection bioassay system for chromium. Leaf disks appeared to be slightly more sensitive to low-dose treatment with copper than chromium, especially during 20-min exposure experiments. Although heavy metals are generally inhibitory to metabolism, the stimulation of short-term PCA rates noted with 5 to 25 micrograms/L copper is not without precedent, as copper-induced stimulation of Potamogeton physiological variables has been reported in the literature. (Doria-PTT)
W91-08077

ACUTE TOXICITY OF PETROLEUM HYDROCARBONS TO THE ARCTIC SHALLOW-WATER MYSID, MYSIS OCULATA (FABRICIUS).
Arctic Biological Station, Ste. Anne de Bellevue (Quebec).
P. N. Riebel, and J. A. Percy.
Sarsia SARIA3, Vol. 75, No. 3, p 223-232, 1990. 3 fig, 6 tab, 41 ref.

Descriptors: *Arctic zone, *Bioassay, *Bioindicators, *Hydrocarbons, *Oil pollution, *Opossum-shrimp, *Toxicity, *Toxicology, *Water pollution effects, Animal behavior, Ecological effects, Environmental monitoring, Marine pollution, Mortality, Oil, Petroleum products, Volatility.

Acute lethal toxicity tests were conducted with young-of-the-year Mysis oculata exposed to oil-in-water dispersions (OWDs) and water-soluble fractions (WSFs) of Norman Wells crude oil. Median lethal concentrations (96-hour LC50s) are among the lowest reported for arctic marine crustaceans, ranging from 0.49 to 0.62 mg/L for WSFs and 4.51 to 7.57 mg/L for OWDs. Sublethal behavioral effects occurred at concentrations as low as 0.3 mg/L for WSFs and 1.5 mg/L for OWDs. Adverse effects were caused primarily by the chemical toxicity of water-soluble hydrocarbons, since there were no apparent physical effects due to dispersed oil droplets. OWDs were more toxic to mysids in sealed containers than in open ones. Median effective concentrations (96-hour ED50s) causing gross behavioral disturbances, moribundity, and 'ecological death' suggest that high molecular weight volatile hydrocarbons found in OWDs are more toxic to mysids than low molecular weight volatiles present in WSFs. Due to its sensitivity, vulnerability, availability in nearshore waters, and ease of maintenance under laboratory conditions, M. oculata is recommended as a test organism for arctic marine toxicity testing and environmental monitoring. (Author's abstract)
W91-08085

HEALTH HAZARDS OF NITRATE IN DRINKING WATER.
Research Inst. for Environmental Diseases, Pretoria (South Africa).
A. P. S. Terblanche.
Water SA WASADV, Vol. 17, No. 1, p 77-82, January 1991. 1 tab, 30 ref.

Descriptors: *Drinking water, *Nitrates, *Public health, *South Africa, *Water pollution effects, *Water quality standards, Biotransformation, Drainage systems, Growth, Milk, Nitrites, Toxicity.

The health effects of nitrate in drinking water are reviewed. Drinking water containing nitrate-nitrogen in excess of 10 mg/L can cause a sometimes fatal blood disorder called methemoglobinemia in infants under the age of six months. Consumption of nitrate has no apparent short-term effects on adults. Nitrate per se is not toxic, but is the precursor of nitrite which is produced through microbial reduction of nitrate in the intestine or in food preparations and which causes methemoglobinemia. Children exposed to excessive nitrate in their diet can have slightly retarded body growth and slower reflexes. The problem is mainly confined to infants who are fed with artificial milk feeds made with water containing elevated nitrate levels. Extensive data on nitrate (as NO3) levels for different water drainage regions in South Africa are available. Levels in South Africa vary between less than 1 mg/L and 40 mg/L. The average nitrate level (as NO3) for 230 drainage regions throughout South Africa falls between 2 and 5 mg/L. The exposure of the South African population to nitrates in drinking water is unknown, as are possible effects of it. The fact that toxic effects can be detected in infants consuming water having only slightly more nitrates than the current standard (10 mgN/L) calls into question the margin of safety provided by that standard. (Doria-PTT)
W91-08095

NICKEL REGULATION OF PHOTOAUTOTROPHY IN A CYANOBACTERIUM.
Banaras Hindu Univ., Varanasi (India). Centre for Advanced Study in Botany.
R. K. Asthana, P. K. Pandey, and S. P. Singh.
Water, Air and Soil Pollution WAPLAC, Vol. 52, No. 3/4, p 263-276, 1990, 7 fig, 47 ref.

Descriptors: *Algal physiology, *Cyanophyta, *Enzymes, *Heavy metals, *Nickel, *Nostoc, *Toxicity, *Water pollution effects, Carbon radioisotopes, Inhibition, Magnesium, Photosynthesis, Plant growth substances, Trace elements.

Nickel, like other cations, is known to be accumulated by algae. The main enzyme of autotrophy, ribulose biphosphate carboxylase (RuBPcase) has been shown to undergo activation with Ni as a substituent of Mg, and has been found to stimulate nitrogenase and uptake hydrogenase activity at lower concentrations in some species. In the diazotrophic cyanobacterium, Nostoc muscorum, Ni inhibited photoautotrophic growth performance, which ceased altogether at concentrations of 15 micromoles. Nitrogenase (N2ase) activity, photosynthetic O2-evolution, photosynthetic C-14 CO2 incorporation, respiratory O2 consumption, and in vitro RuBPcase activity were also affected in response to Ni. C-14 CO2-uptake rapidly decreased in cultures treated with 10 micromoles and was more sensitive to Ni compared to N2ase activity which showed a 4-fold increase at 1 micromole, although higher concentrations proved strongly inhibitory. O2-evolution and respiratory O2-uptake persisted until concentrations reached 1,000 micromoles. Lower Ni concentrations (1 micro mole and 5 micro mole) serves as an activator of N2ase as well as RuBPcase, while elevated concentrations inhibited enzyme activity by interaction with the -SH group. It is proposed that Ni inhibition is mainly through the regulation of RuBPcase activity in the cyanobacterium. (Doyle-PTT)
W91-08118

COMPARATIVE SEED GERMINATION TESTS USING TEN PLANT SPECIES FOR TOXICITY ASSESSMENT OF A METAL ENGRAVING EFFLUENT SAMPLE.
Illinois State Water Survey Div., Peoria. Water Quality Section.
W. Wang, and P. H. Keturi.
Water, Air and Soil Pollution WAPLAC, Vol. 52, No. 3/4, p 369-376, 1990, 1 fig, 4 tab, 18 ref.

Descriptors: *Bioassay, *Bioindicators, *Germination, *Metal-finishing wastes, *Phytotoxicity, *Toxicity, *Wastewater analysis, Comparative studies, Industrial wastewater, Plant growth, Plant pathology, Rice, Seeds, Tomatoes, Water quality standards.

An effluent sample was collected from the acid bath of a metal engraving plant where the sample had been pretreated with lime to pH 10.6. The sample was adjusted to pH 7.37 (and in a second test to 7.25) and diluted to a series of solutions using hard, standard water. The seed germination method was employed to test the phytotoxicity of the sample to ten plant species. The experimental results of this study compared to previous studies indicated that cabbage, carrot, Japanese millet, oat, and wheat lost some viability during storage. The germination rates of these species fell below 85% in this study, although the rates of cabbage, Japanese millet, and wheat were above 85% in previous studies. Of the remaining species with adequate germination rates, cucumber and white proso millet were relatively insensitive to the effluent toxicity. The promising candidates for toxicity testing were rice, lettuce, and tomato, based on long shelf life, high germination rate and sensitivity to toxicity. (Author's abstract)
W91-08123

EFFECT OF ACID STRESS ON THE EMBRYONIC DEVELOPMENT OF THE COMMON CARP (CYPRINUS CARPIO).
Katholieke Univ. Nijmegen (Netherlands). Dept. of Biology.
F. G. F. Oyen, L. E. C. M. M. Camps, and S. W. Wendelaar Bonga.
Aquatic Toxicology AQTODG, Vol. 19, No. 1, p 1-12, February 1991. 6 fig, 2 tab, 33 ref. Commission of European Communities, 4th Environmental Research and Development Programme Project EV4V-0117-NL.

Descriptors: *Acid rain effects, *Acidic water, *Carp, *Embryonic growth stage, *Fish eggs, *Hatching, *Teratogenicity, *Water pollution effects, Bioassay, Fish pathology, Hydrogen ion concentration, Median tolerance limit, Mortality, Toxicity.

The effects of acid stress on the embryonic development of one of the most important cyprinids, the common carp (Cyprinus carpio) was studied using the following parameters: rate of embryonic development, embryonic and larval mortality, hatching dynamics and spinal cord deformation. Sensitivity of eggs and sac fry of the common carp to pH

levels in the range of 4.5 to 7.5 was assessed up to 117 hours after fertilization. In the pH range between 4.75 and 5.2, egg mortality was highest and a delay in the rate of embryonic development and hatching was observed in the surviving embryos. Even at pH 5.5, effects became apparent through delayed rate of embryonic development, increased mortality percentage, delayed hatching time of the eggs, elongation of the hatching process, and elevated deformation percentage. A strong increase of spinal cord deformation of sac fry occurred in the lower pH ranges (pH 5.5 to 4.75). No difference in larval deformation percentage was observed in the pH range of 7.5 to 5.9. The critical pH level for carp eggs ranged between 4.75 and 5.2, which is about 1 pH unit higher than the critical value for juveniles. This indicated that carp populations in nature may already be seriously threatened. Common carp appeared to be more sensitive to acid stress than may other species of fish. (VerNooy-PTT)
W91-08158

INTERACTION OF PH, DISSOLVED ORGANIC CARBON, AND TOTAL CARBON IN THE DETERMINATION OF IONIC COPPER AND TOXICITY.
Washington Univ., Seattle. School of Fisheries.
J. P. Meador.
Aquatic Toxicology AQTODG, Vol. 19, No. 1, p 13-32, February 1991. 8 fig, 1 tab, 45 ref.

Descriptors: *Bioavailability, *Chemical speciation, *Copper, *Hydrogen ion concentration, *Total carbon, *Toxicity, *Water pollution effects, *Waterfleas, Bioassay, Cations, Chemical interactions, Daphnia, Dissolved organic carbon, Metal complexes, Mortality, Regression analysis.

The species of copper and their abundance are known to be controlled in the natural environment by pH, organic complexes, inorganic ligands, and surfaces such as sediment and particulate carbon. The bioavailability of copper to Daphnia magna was studied in a complete three factor experiment with variable total copper (TCU) (0, 10, 25, 50, and 75 ng/mL (ppb)), pH (7, 7.5, and 8), and naturally-derived dissolved organic carbon (DOC) (0, 1, 2, 3.75, and 6 mg/L). Free ion concentration, which is infrequently reported, was quantified because without its determination it could not be ascertained if the reduction in toxicity by complexation was due to a reduction in the concentration of the free metal (as the only toxic species) or the complexed metal having a lower toxicity than the free metal. Both pH and DOC were important in controlling the amount of ionic copper (for a given total copper concentration) and a nonlinear regression model was developed which explained 94% of the variability in the data. Mortality of Daphnia magna was highly correlated with ionic copper under pH 7 at 24 and 48 hours (r squared = 0.90 and 0.96) and less so at higher pH suggesting that copper complexes may be contributing to the response. When toxicity was expressed in terms of ionic copper, it was concluded that a given amount of ionic copper produced more toxicity as pH increased. The LC50 for total copper decreased by a factor of 1.6 to 2.9, depending on pH, from 24 to 48 hours. The 48-hour LC50 for D. magna exposed to ionic copper was in the order of 0.5 nM (0.03 ng/mL). (VerNooy-PTT)
W91-08159

PRELIMINARY STUDIES ON THE ACUTE EFFECT OF LINDANE (GAMMA-HCH) ON BRAIN SEROTONINERGIC SYSTEM IN RAINBOW TROUT ONCORHYNCHUS MYKISS.
Santiago Univ. (Spain). Dept. of Physiology.
M. V. Rozados, M. D. Andres, and M. A. Aldegunde.
Aquatic Toxicology AQTODG, Vol. 19, No. 1, p 33-40, February 1991. 2 fig, 3 tab, 41 ref.

Descriptors: *Animal metabolism, *Biochemistry, *Lindane, *Pesticide toxicity, *Toxicity, *Toxicology, *Trout, *Water pollution effects, Animal tissues, Bioassay, Biochemical tests, Brain, Liquid chromatography, Organochlorine pesticides, Sublethal effects, Tissue analysis.

Adult rainbow trout Oncorhynchus mykiss were exposed to 0.05 mg/L and 0.1 mg/L of the organochlorinated pesticide lindane (gamma-HCH) for two hours. The response was determined by measuring serotonin (5-HT) and 5-hydroxy indoleacetic acid (5-HIAA) levels by high performance liquid chromatography with electrochemical detection (HPLC-EC) in five brain regions (hypothalamus, medulla oblongata, telencephalon, tectum optic and remaining portion) and brain, seric and hepatic tryptophan concentrations by fluorimetry. While hepatic tryptophan decreased significantly ($p < 0.05$) with both doses, significant increased levels of seric tryptophan ($p < 0.05$) appeared with the higher dosage. Tryptophan levels did not show significant variations in brain regions. Brain 5-HT increased significantly ($p < 0.05$) in hypothalamus but decreased ($p < 0.05$) in tectum optic. The highest ratio of 5-HT/5-HIAA appeared in hypothalamus ($p < 0.05$) and the lowest ($p < 0.01$) in telencephalon. These results show that the effects of lindane on the cerebral serotoninergic metabolism vary for the brain regions studied, and this implies that the mode of action is specific. Therefore, this could induce specific alterations of the behavior controlled by these brain regions. (Author's abstract)
W91-08160

PATHOLOGIC ALTERATIONS IN EARLY LIFE STAGES OF LAKE TROUT, SALVELINUS NAMAYCUSH, EXPOSED TO 2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN AS FERTILIZED EGGS.
New York State Coll. of Veterinary Medicine, Ithaca. Dept. of Avian and Aquatic Animal Medicine.
J. M. Spitsbergen, M. K. Walker, J. R. Olson, and R. E. Peterson.
Aquatic Toxicology AQTODG, Vol. 19, No. 1, p 41-72, February 1991. 10 fig, 6 tab, 46 ref. NOAA Grant NA84AA-D-00065, University of Wisconsin Sea Grant Project R/MW-40, Cooperative Investigations of Fish Pathology Contract C002301, NIEHS Grants ES01985 and ES07015.

Descriptors: *Chlorinated aromatic compounds, *Dioxins, *Fish eggs, *Fish pathology, *Teratogenicity, *Toxicity, *Trout, *Water pollution effects, Animal tissues, Bioaccumulation, Bioassay, Cardiovascular system, Growth stages, Lake fisheries, Mortality, Tritium.

Fertilized lake trout eggs exposed to vehicle or graded concentrations of (H3)-2,3,7,8-tetrachlorodibenzo-p-dioxin (tritiated TCDD) in water for 48 hours accumulated 1, < 15, 40 or 400 ppt (parts per trillion) (H3)-TCDD. The exposed eggs were then transferred to flowing (H3)-TCDD free water where they remained throughout early development. Lake trout embryos developed normally in all groups until one week prior to hatch. At this time, retrobulbar, meningeal and subcutaneous hemorrhages were evident in may embryos and sac fry that were derived from eggs containing 400 ppt (H3)-TCDD. High mortality prior to or during hatching accompanied these lesions. All sac fry which survived hatching in the 400 ppt TCDD group developed severe subcutaneous edema, with cessation of blood circulation in the yolk sac and body. Necrosis of the retina, brain, and spinal cord occurred in morbid embryos and sac fry. All sac fry in the 400 ppt TCDD group showed arrested development from the time of hatching and all died prior to swim-up. One percent of sac fry in the vehicle control and < 15 ppt TCDD groups, and 2% in the 40 ppt TCDD group, exhibited blue-sac disease, an edematous syndrome identical grossly and nearly identical microscopically to that observed in the 400 ppt TCDD group. Thus the cardiovascular system appears to be the initial tissue affected in both the TCDD toxicity syndrome and in blue-sac disease of developing lake trout. Lesions in other organs including brain, retina and liver develop as a result of circulatory derangements, anemia and hypoxia. (Author's abstract)
W91-08161

CU AND ZN UPTAKE BY HALIMIONE PORTULACOIDES (L.) AELLEN: A LONG TERM ACCUMULATION EXPERIMENT.
Universidade Nova de Lisboa (Portugal).
F. Reboredo.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 46, No. 3, p 442-449, March 1991. 3 fig, 14 ref.

Descriptors: *Bioaccumulation, *Copper, *Halophytes, *Heavy metals, *Path of pollutants, *Phytotoxicity, *Soil contamination, *Water pollution effects, *Zinc, Bioassay, Chronic toxicity, Estuarine environment, In vitro tests, Leaves, Plant morphology, Plant tissues, Portugal, Roots, Sado River, Tissue analysis, Vascular tissues, Wastewater pollution.

Halimione portulacoides is one of the most representative halophytes of the salt-marshes of the Sado River estuary in Portugal. The Sado basin receives an important input of residual elements from industries, and also the untreated domestic sewage from Setubal, a populous city located in the mouth of the estuary. In order to study the uptake and pattern of accumulation of copper (Cu) and zinc (Zn) by the roots, stems and leaves of Halimione, plants were cultivated in vitro and treated daily with solutions containing 5, 25, and 50 ppm Cu (as CuCl2) and 50, 100 and 150 ppm Zn (as ZnCl2). Halimione plants were treated with 5 ppm Cu during 8 weeks without apparent damage, while plants treated with 25 and 50 ppm exhibited several injuries during the 5th week of treatment. These injuries, such as foliar necrosis of mature leaves and withering of a majority of young leaves of the shoots, were probably caused by high levels of Cu in the leaves (36.5 and 53.8 ppm, respectively, compared with 20.0 ppm for controls). Copper accumulated in the first two weeks; after that time accumulation was insignificant. Zinc level of 50 to 150 ppm and exposure times of 2, 4, and 8 weeks did not induce changes in the external morphology of Halimione. Maximum Zn levels observed in the roots was 185.8 ppm and leaves was 120.4 ppm. After 8 weeks exposure to 5 ppm Cu and 150 ppm Zn, leaves contained 21.6 ppm Cu and 120.4 Zn, respectively. Although absorption from contaminated soils is not negligible, it appears to be slow compared with absorption from water. (VerNooy-PTT)
W91-08163

CHANGES IN ULTRAWEAK LUMINESCENCE FROM LIVING FISH INDUCED BY THREE CHEMICALS.
Beijing Municipal Research Inst. of Environmental Protection (China).
W. Yingyan, M. Yuqin, L. Da, L. Shenxun, and Z. Yujing.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 46, No. 3, p 456-460, March 1991. 6 tab, 8 ref.

Descriptors: *Bioindicators, *Bioluminescence, *Nitrogen compounds, *Organophosphorus pesticides, *Pesticide toxicity, *Toxicity, *Uranium, *Water pollution effects, *Zebra fish, Azides, Bioassay, Cyclophosphamide, Dose-response relationships, Mortality, Sublethal effects.

Ultraweak luminescence (ULI) is a low-intensity emission inherently associated with processes such as oxidative metabolism, cell division, carcinogenesis, photosynthesis and cell death. Zebra fish emit spontaneous ultraweak luminescence, which varies in accordance with seasonal water temperature. ULI from adult zebra fish (Brachydanio rerio) was measured before and after exposure to uranium dioxide (UO2), sodium azide (NaN3) and cyclophosphamide (CP). The photon count rates increased with increasing UO2 concentrations from 0.05 to 0.3 micrograms/mL, reflecting the degree of damage to the luminescence function. All fish died at over 0.3 micrograms/mL UO2. ULI values for fish treated with 0.05, 0.1, 0.2, and 0.3 micrograms/mL UO2 were 9, 13, 19, and 27 photon count rates/sec/cm, respectively. For 0.05, 0.1, and 0.2 mg/mL NaN3 the values were 5, 3, and 1 photon count rates/sec/cm, respectively, and for 0.4, 0.8, 1.6, and 2.4 mg/mL cyclophosphamide the values were 32, 20, 13, and 6 photon count rates/sec/cm, respectively. UO2 induced a decrease of photon emission from the living fish and its induc-

tion increased with the increase of UO2 concentrations. By contrast, NaN3 or CP induces an increase in luminescence intensity, and its induction decreases with an increase of concentration. There were significant correlations between the doses of chemical toxicants and changes of ULI induced by chemicals. ULI may potentially be used as a control for toxicity tests to prove the accuracy of experimental results. (VerNooy-PTT)
W91-08164

INFLUENCE OF SULFATE, CA, AND MG ON THE ACUTE TOXICITY OF POTASSIUM DICHROMATE TO DAPHNIA SIMILIS.
Osaka City Inst. of Public Health and Environmental Sciences (Japan).
M. Hosokawa, G. Endo, K. Kuroda, and S. Horiguchi.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 46, No. 3, p 461-465, March 1991. 3 fig, 11 ref.

Descriptors: *Calcium, *Chromates, *Magnesium, *Sulfates, *Toxicity, *Toxicology, *Waterfleas, Bioassay, Daphnia, Dose-response relationships, Ions, Mortality, Sublethal effects, Synergistic effects, Water pollution effects.

Daphnia similis were collected from a pond and cultured for three years in reconstituted water. Neonate daphnia were exposed in static acute toxicity tests (24 and 48 hours) using water containing variable amounts of calcium chloride (0.25 to 1.0 mM), magnesium chloride (0.1 to 1.0 mM) and sodium sulfate (0.1 to 1.0 mM). The toxicity of potassium dichromate (K2Cr2O7) was strongly decreased by the addition of sulfate and the EC50 (50% immobilization) values were logarithmically proportional to sulfate concentrations in the test waters. The toxicity of potassium dichromate was dependent on the calcium concentration in a similar manner. D. similis neonates died within 24 hours in media without calcium (and without feeding), but survived more than 2 days in the medium containing only calcium chloride. The effect of magnesium on the toxicity of potassium to D. similis was weak. Experimental results show that sulfate, calcium and magnesium, commonly contained in aquatic environments, decreased the toxicity of potassium dichromate which is recommended as a reference toxicant in the acute toxicity test. (VerNooy-PTT)
W91-08165

CHEMICAL SPECIATION AND BIOAVAILABILITY OF CU(II): STUDY OF THE IONIC COPPER(II) AND BIS(GLYCINATE)-COPPER(II) ACCUMULATION BY LEMNA SPECIES.
Ceskoslovenska Akademie Ved, Ceske Budejovice. Inst. of Landscape Ecology.
F. Benda, and J. Kouba.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 46, No. 3, p 466-472, March 1991. 1 fig, 1 tab, 8 ref.

Descriptors: *Bioavailability, *Chemical speciation, *Copper, *Duckweed, *Metal complexes, *Path of pollutants, *Phytotoxicity, *Toxicology, *Water pollution effects, Cations, Chemical degradation, Copper compounds, Diffusion, Plant physiology, Toxicity.

An examination was made of the accumulation of copper(II) in, and its toxic effect on, duckweed, a plant which exhibits extremely high concentration factors. The effect of Cu(++) was investigated by adding it to the 'minimal' medium in two forms: copper sulfate (CuSO4) and bis(glycinate-copper (Cu(Gly)2). The glycinate complex was chosen to model the function of a neutral species involving a nontoxic ligand, for which--in contrast to the hydrated Cu(++) species--direct permeation through the cell wall is conceivable. Duckweed was exposed to copper concentrations of 10 to 100 mg/L for 3 days. The Cu content of the duckweed biomass was a roughly linear function of the concentration. For Cu(Gly)2, however, increased concentration was not associated with increased accumulation, indicating that Cu intake was not related to the Cu(++) released by dissociation of the complex species. Dependence of accumulation on the concentration of Cu(Gly)2 in the medium suggests that rather than diffusion, the degradation process inside the cell was the controlling phenomenon. This rendered the accumulation effect more intense at lower Cu concentrations (10 mg/L). However, it also enhanced the toxic effect and prevented the resulting accumulation from increasing with increasing concentration of Cu(Gly)2 in the medium. (VerNooy-PTT)
W91-08166

TOXIC IMPACT OF ALDRIN ON ACID AND ALKALINE PHOSPHATASE ACTIVITY OF PENAEID PRAWN, METAPENAEUS MONOCEROS: IN VITRO STUDY.
Sri Venkateswara Univ., Kavali (India). Div. of Toxicology.
M. S. Reddy, P. Jayaprada, and K. V. R. Rao.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 46, No. 3, p 479-484, March 1991. 2 tab, 15 ref.

Descriptors: *Aldrin, *Biochemistry, *Insecticides, *Pesticide toxicity, *Phosphatases, *Shrimp, *Toxicity, *Toxicology, *Water pollution effects, Animal tissues, Bioassay, Bioindicators, Chlorinated hydrocarbon insecticides, Crustaceans, Dose-response relationships, Enzymes, Estuarine fisheries, India, Inhibition, Sublethal effects, Tissue analysis.

Although the penaeid prawn, Metapenaeus monoceros is considered to be a sensitive indicator of marine or estuarine pollution, studies concerning the impact of aldrin on biochemical aspects of crustaceans are very limited. A study was conducted on the in vitro effects of aldrin, an organochlorine insecticide, on the acid and alkaline phosphatase activity levels in selected tissues of penaeid prawn. Intermolt prawns were collected from the Buckingham canal, near Kavali seacoast, Andhra pradesh, India and acclimatized to laboratory conditions for 1 week. Selected tissues were exposed to 8, 16, or 24 micrograms/L of aldrin. Both acid phosphatase (ACPase) and alkaline phosphatase (ALPase) activities were significantly inhibited after addition of aldrin. The degree of inhibition was dose-dependent and considerable inhibition occurred even in the low concentrations. Maximum inhibition in ACPase activity was observed in 24 micrograms/L of aldrin in vitro addition in hepatopancreas (-66%; $p < 0.001$) as compared to control values, whereas minimum inhibition was observed in the muscle and brain tissues (-28%; $p < 0.001$) after treatment of 8 micrograms/L of aldrin. However, ALPase was inhibited maximum in stomach (-62%; $p < 0.001$) and minimum in the brain tissue (-8%; $p < 0.001$). This investigation indicates that any alteration in the activities of ACPase and ALPase created disturbances in the normal functioning of the various tissues of M. monoceros after in vitro addition of aldrin. (VerNooy-PTT)
W91-08168

SKELETAL DEFORMITIES AND TRACE METAL CONTENTS OF EUROPEAN SMELT, OSMERUS EPERLANUS, IN THE ELBE ESTUARY.
Kiel Univ. (Germany, F.R.). Inst. fuer Meereskunde.
C. Pohl.
Meeresforschung MEERDW, Vol. 33, No. 1, p 76-89, December 1990. 6 fig, 6 tab, 47 ref.

Descriptors: *Elbe River, *Fish pathology, *Heavy metals, *Smelt, *Stream pollution, *Teratogenicity, *Trace metals, *Water pollution effects, Animal tissues, Cadmium, Germany, Lead, Rivers, Skeleton, Tissue analysis.

The Elbe River between the North Sea and Hamburg (Germany), one of the busiest shipping routes, is considered to be highly polluted. Each month from March 1985 until March 1986, European smelt, Osmerus eperlanus, were caught at 15 stations in the tidal Elbe estuary. A total of 55,655 individuals from 142 catches of 0 group (age less than one year) smelts were examined for externally visible skeletal deformities. In 108 catches, the deformity prevalence ranged between 0 and 2% and in the remaining 34 catches, the deformation rate was greater than 2% with the value for individual catches ranging to 45%. Length, weight and the condition factor of the deformed smelt were significantly less than those of normal specimens. In addition to the statistical data, the concentrations of cadmium, lead, copper and zinc in the liver and muscle tissue of 50 malformed and 69 normally developed individuals in age groups 0 and 1 were determined by graphite furnace atomic absorption spectroscopy (AAS). The levels of these four trace metals are considered to be low. However, significantly higher lead and cadmium concentrations were found in the liver tissue of malformed fish of the 0 group. (Author's abstract)
W91-08181

LOCAL FISH KILL IN A POND AT THE GERMAN NORTH SEA COAST ASSOCIATED WITH A MASS DEVELOPMENT OF PRYMNESIUM SP.
Forschungs- und Technologiezentrum Westkuste, Buesum (Germany, F.R.).
W. Dietrich, and K. J. Hesse.
Meeresforschung MEERDW, Vol. 33, No. 1, p 104-106, December 1990. 2 fig, 3 ref.

Descriptors: *Algal blooms, *Brackish water, *Coasts, *Eel, *Fishkill, *Marine algae, *Toxicity, *Water pollution effects, Germany, Mortality, Phytoplankton, Ponds, Salinity, Water sampling.

Increasing concern about algal blooms has resulted in a report on a local fish kill at the German North Sea coast, which occurred more than 12 years ago. At the end of May 1978 more than 100 eels (Anguilla anguilla L.) died, within a few days, in a pond on the eastern coastal region of the German Bight. The pond, with an area of about 1000 sq m and approximately 2 m deep, is about 2 miles from the coastline. The entire population was presumably killed as no fish were caught the following autumn. A water sample taken from the surface of the pond on June 1st revealed a high concentration (10 million cells/L) of an unarmored nanoflagellate, which was a species of the genus Prymnesium. The alga showed a close resemblance to P. parvum which is extremely ichthyotoxic. The occurrence of P. parvum, which is restricted to marine as well as brackish waters, in an inland pond, can be retraced. The ditches and sluices were flooded 2 years before, in the dry early spring of 1976, and thus sea water found its way into the marsh and filled the ponds, giving rise to salinities of about 3 ppt and bringing about an invasion of brackish water organisms. In the same year organisms typical for brackish waters were found in other inland ponds, e.g., the opossum shrimp Neomysis integer Leach, and the shrimp Palaemonetes varians Leach. The numerous, but poorly investigated, ponds and basins of the west coast represent favorable sites for a mass development of various types of potentially toxic phytoplankton species which may initiate near-shore blooms or poison shellfish, and should thus be carefully controlled. (VerNooy-PTT)
W91-08182

TOXICITY REDUCTION IN INDUSTRIAL EFFLUENTS.
For primary bibliographic entry see Field 5G.
W91-08192

TOXICITY IDENTIFICATION EVALUATIONS.
Eckenfelder, Inc., Nashville, TN.
For primary bibliographic entry see Field 5A.
W91-08194

5D. Waste Treatment Processes

HAZARDOUS AND INDUSTRIAL WASTES: PROCEEDINGS OF THE 21ST MID-ATLANTIC INDUSTRIAL WASTE CONFERENCE.
June 25-27, 1989. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1989. 732p. Edited by Charles A. Cole and David A. Long.

Descriptors: *Hazardous wastes, *Industrial wastes, *Waste disposal, *Waste management, *Waste treatment, *Wastewater treatment, *Water pollution control, Activated carbon, Anaerobic digestion, Biological treatment, Composting, Conferences, Groundwater management, Microorganisms, Pennsylvania, Photolysis, Pretreatment of wastewater, Rehabilitation, Risk assessment, Sludge disposal, Sludge treatment, Soil treatment.

The proceedings of the twenty-first Mid-Atlantic Industrial Waste Conference, that was held June 25-27, 1989, examine many aspects of industrial waste treatment and disposal. The conference was held at Penn State University, Pennsylvania. It gave industrial, business, academic, and regulatory representatives an opportunity to exchange information in both formal presentations and informal discussions. Topics explored included: sludge treatment and disposal techniques; waste minimization; innovative technologies, such as aspiration stripping, activated carbon, fixed film biological treatment, and metal removal; land treatment, disposal, storage and clean-up options; wastewater treatment technologies; regulations; ground water systems impact; risk assessment; and remediation. Wastewater treatment options examined included photolysis, biological treatment, pretreatment advantages, activated sludge systems, and anaerobic reactors. Remediation measures, such as composting, microbial dechlorination, soil washing, and pneumatic fracturing were discussed at the conference. A number of universities sponsored the conference, in cooperation with Pennsylvania, Maryland, and Delaware governmental agencies and organizations. (See W91-07140 thru W91-07187) (Mertz-PTT)
W91-07139

DEWATERING OF PLATING WASTE SLUDGES ON ARTIFICIAL MEDIA BEDS.
R. L. Bates, W. L. Heaner, and W. T. Rhodes.
IN: Hazardous and Industrial Wastes: Proceedings of the 21st Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1989. p 16-29. 4 tab.

Descriptors: *Dewatering, *Hazardous wastes, *Metal-finishing wastes, *Sludge drying, *Sludge treatment, Industrial wastes, Military reservations, Sludge, Waste management, Wastewater treatment.

The United States Navy, Southern Division, Naval Facilities Engineering Command, recently completed designs and construction of dewatering systems for treatment of industrial sludges at two installations in Southeastern states and one in the South Central U.S. Under Subpart D of 40 CFR (Code of Federal Regulations) 261 regulations. Industrial waste treatment facilities at these sites were categorized as F006 hazardous wastes: wastewater treatment sludges from electroplating operations. Planning, design and facilities construction was completed by 1988. Facility designs were based on widely used and proven technologies, sludge conditioning by polymer addition and gravity dewatering on artificial media (Wedgewater) beds. Typical facility configurations were adapted for use with the hazardous sludges by incorporating double wall tank and double wall pipe features conforming to Subpart D regulations. To achieve minimal possible cake moistures and least cost cake disposal the installations structures and containment tanks were roofed. Successful dewatering accomplished waste minimization (mass and volume reductions) of the hazardous wastes that require transportation and disposal. The Navy's diligence concerning implementation achieved initial system operations in advance of regulatory agency compliance schedules, and was indicative of Navy dedication to environmental protection and betterment. (See also W91-07139) (Mertz-PTT)
W91-07141

DETOXIFICATION OF FOUNDRY AIR POLLUTION CONTROL SLUDGES.
Pennsylvania State Univ., University Park. Dept. of Civil Engineering.
L. G. Contos, R. W. Regan, and J. S. O'Hearn.
IN: Hazardous and Industrial Wastes: Proceedings of the 21st Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1989. p 30-41. 5 fig, 2 tab, 14 ref.

Descriptors: *Detoxification, *Hazardous wastes, *Industrial wastes, *Sludge treatment, *Waste treatment, Cadmium, Heavy metals, Lead, Sludge stabilization, Waste stabilization.

A cost-effective strategy for the management of foundry waste materials was examined. It was determined that stabilizing the sludge via chemically and physically chelating metals within the floc material should decrease the surface area across which transfer or loss of contaminated pollutants can occur, and therefore, detoxify the metal constituents contained in the waste. The treatment process was based on utilizing a waste by-product from a nearby industry and using this material to chelate soluble metals within the sludge, thereby stabilizing the sludge. Due to the concentrations of lead and cadmium, the sludge was classified as a hazardous waste. The composite sample created for this analysis consisted of sludge from 13 foundries. Although the mean metal concentrations of any sludge at any time may be considered non-hazardous, the concentrations produced by composite samples clearly exceeded the hazardous waste limit. Only through analyzing composite samples could the variations in the sludge be characterized and a treatment system developed. A primary concern of the detoxification process was reducing leachate concentrations from cadmium. It was shown that the detoxification of sludge could be successfully accomplished by adding a 5% dry weight addition of the Metal Inhibiting Compound to the sludge. The foundry system must be evaluated to assess the degree of variability in the wastewater and the sludge. (See also W91-07139) (Mertz-PTT)
W91-07142

TRIAL BURN EXPERIENCE WITH SLAGGING-MODE ROTARY KILN TECHNOLOGY.
Weston (Roy F.), Inc., West Chester, PA.
R. J. Buchanan, and P. W. Falcone.
IN: Hazardous and Industrial Wastes: Proceedings of the 21st Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1989. p 42-57. 2 fig, 5 tab, 3 ref.

Descriptors: *Hazardous waste disposal, *Hazardous wastes, *Incineration, *Waste treatment, Carbon tetrachloride, Destruction removal efficiency, Permits, Resource Conservation and Recovery Act, Rotary kiln, Slag, Texas, Trial burn, Waste disposal, Wastewater treatment.

RCRA (Resource Conservation and Recovery Act) regulations require the owner/operator of a hazardous waste incineration facility to conduct a trial burn to ensure compliance with operational, design, and current emission regulations. Monitoring of specific operating parameters, such as combustion temperature, waste feed rate, and indicators of combustion gas velocity, is conducted. Rollins Environmental Services conducted a trial burn on the Incinerator Train II at the Rollins Deer Park, Texas, facility during May 1988. The program designed demonstrated that the incinerator train would comply with the RCRA, Texas Water Commission, and Texas Air Control Board regulations while operated under varied load conditions. The trial burn entailed three sampling runs per day over the course of 5 days, with as many as five different wastestreams fed to the incinerator. The waste feed streams were spiked with carbon tetrachloride to demonstrate the Destruction Removal Efficiency of the incinerator system under different operating conditions. The slagging mode rotary kiln proved to be a consistent and technically superior thermal destruction device that meets or exceeds all appropriate permit requirements. Several advantages of the slagging rotary kiln include: consistently high destruction removal efficiency; direct feeding of metal containers without preshredding; reduced particulate emissions; reduced excess air requirements; reduction in total auxiliary energy consumption; and a cost effective increase of incremental thermal destruction capacity as compared to the capital investment. (See also W91-07139) (Mertz-PTT)
W91-07143

HAZARDOUS WASTE MINIMIZATION MEASURES IMPLEMENTED BY METAL-PLATING PLANTS IN THE SAN FRANCISCO BAY AREA.
Stanford Univ., CA. Dept. of Civil Engineering.
L. D. Duke.
IN: Hazardous and Industrial Wastes: Proceedings of the 21st Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1989. p 61-75. 2 tab, 8 ref.

Descriptors: *Hazardous wastes, *Heavy metals, *Industrial wastes, *Metal-finishing wastes, *Waste management, *Waste minimization, *Wastewater treatment, Acids, Cyanide, Recycling, San Francisco, Sludge drying, Waste treatment.

Manufacturers in the metal finishing industry constantly face the problem of effective hazardous waste management. Metal plating processes rely on hazardous materials: heavy metals are an inherent part of the products, and must be used in liquid form; and the most common process methods use cyanide solutions and highly acidic metal solutions. Measures that minimize the hazardous waste generated by manufacturers are a well-justified response to the high costs and administrative burdens of handling hazardous waste. Of 26 metal plating firms in the San Francisco Bay Area who generated fairly large quantities of hazardous waste as of 1987, 20 took one or more actions to minimize hazardous waste. The kinds of measures implemented by these firms included sophisticated process changes, complete end-of-pipe treatment systems, volume reduction steps through sludge dewatering, and straightforward operating procedure changes. Each kind of action achieved significant reduction in the quantity of hazardous waste generated; five actions eliminated a critical waste stream. (See also W91-07139) (Mertz-PTT)
W91-07144

WASTE MINIMIZATION: CASE STUDY.
BCM Engineers, Inc., Plymouth Meeting, PA.
H. D. Alexander, and J. V. Interrante.
IN: Hazardous and Industrial Wastes: Proceedings of the 21st Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1989. p 76-92. 3 tab, 7 ref.

Descriptors: *Industrial wastes, *Waste management, *Waste minimization, *Waste recovery, Cost analysis, Economic aspects, Hazardous wastes, Recycling, Wastewater treatment.

Waste minimization is the process of reducing to the maximum economical extent, the amount of solid and hazardous waste that a facility sends to a landfill, an incinerator, or other disposal facility. This can be accomplished either by not creating the water (source reduction) or by extracting from the waste useful products or raw materials (recycling). There are basically five steps in a waste minimization assessment: develop an accurate inventory of the amount of waste generated by the facility; determine how these wastes are produced, handled, and disposed of; choose the minimization options with the best chance for real waste reductions and savings; perform a comprehensive assessment of all options; and present results to management. Waste minimization assessments were conducted for several industrial facilities. An inventory of the amount of waste generated by one facility showed that the facility produced 11 types of hazardous waste. Two non-hazardous waste streams, oily wastewater and synthetic cloth waste, were also included. Machine coolant was utilized in a number of metal working machines at the facility. A favorable economic evaluation led to the recommendation that the facility implement a coolant recycling program using a portable service cart. At another facility industrial towels and rags were used to wipe down parts and machinery, to wipe up spills, and for general cleaning. The industrial facility studied used approximately 324,000 rags each year and shipped them out as hazardous waste to be incinerated in 260 drums at a cost of $517/drum. It was recommended that the facility

switch over to a laundered rag system. Many industrial facilities inadvertently increase the volume of their waste streams through improper management of raw materials and products. Improved management can achieve a double savings by reducing hazardous waste disposal costs and raw material costs. In high quality photographic film and film processing the element silver is used. The average daily sewerage flow from the industrial facility was approximately 120,000 gallons and the silver load was 0.18 pounds per work day. It was determined that silver recovery could reduce this concentration by 95%. (See also W91-07139) (Mertz-PTT)
W91-07145

RECYCLING OF BY-PRODUCT GYPSUM.
Pennsylvania State Univ., University Park.
A. Nanni.
IN: Hazardous and Industrial Wastes: Proceedings of the 21st Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1989. p 93-105. 7 fig, 1 tab, 13 ref.

Descriptors: *Gypsum, *Recycling, *Waste recovery, *Waste utilization, Agricultural practices, Construction materials, Industrial wastes, Waste management, Waste stabilization.

The total production of synthetic gypsum in the United States will be approximately 60 to 65 million tons per annum by 1990, and the amount presently stockpiled is unofficially estimated to be over 800 million tons. The present U.S. utilization of by-product gypsum is limited to less than 1 million tons per year, primarily for agricultural uses. Of the total 8 million tons of by-product gypsum recycled throughout the world, 70% of that is done in Japan. Utilization of by-product gypsum in the construction industry is possible in areas outside the traditional domain of the natural mineral. This is the result of the proven ability of the finely divided gypsum powder to solidify under static or dynamic pressure. The production of synthetic gypsum, mainly generated by the phosphoric acid industry and flue gas desulfurization, has reached a magnitude that warrants the need for recycling options. Laboratory studies and pilot projects have demonstrated that raw by-product gypsum can be successfully used as a construction material either by itself or in addition to traditional aggregates and/or portland cement for secondary roads, road bases and building products. (See also W91-07139) (Mertz-PTT)
W91-07146

CLEAN COAL TECHNOLOGY WASTE CHARACTERIZATION.
Argonne National Lab., IL. Energy and Environmental Systems Div.
R. W. Peters, and C. A. Wentz.
IN: Hazardous and Industrial Wastes: Proceedings of the 21st Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1989. p 106-132. 10 tab, 29 ref.

Descriptors: *Coal, *Coal wastes, *Hazardous wastes, Department of Energy, Emission control, Incineration, Industrial wastes, Waste characterization.

Clean coal technologies signify a new generation of highly efficient, environmentally clean, coal-based energy processes. The U.S. Department of Energy (DOE) has a Clean Coal Technology Program, that has a major goal of improving the options available to reduce emissions from coal-fired power plants. To accomplish this goal, DOE is pursuing the development and demonstration of technologies that will result in more efficient and effective emissions controls. Although some sources report that no hazardous wastes are generated from advanced combustors, alternative fuels, advanced physical coal preparation, fluidized-bed combustion, flue-gas cleanup, coal liquefaction, and coal gasification; the potential for hazardous waste generation is still widely discussed. Results of a review of the technical literature revealed that relatively little information characterizing solid wastes from clean coal technologies existed in the open literature. In Phase II of the study, industrial data, records, and reports were reviewed during site visits. The available data indicate that the majority of solid wastes resulting from these technologies would not be classified as hazardous under RCRA (Resource Conservation and Recovery Act) standards. (See also W91-07139) (Mertz-PTT)
W91-07147

INTERACTIONS OF HEXAVALENT AND TRIVALENT CHROMIUM WITH ACTIVATED CARBON.
Pittsburgh Univ., PA. Dept. of Civil Engineering.
S. K. Ouki, and R. D. Neufeld.
IN: Hazardous and Industrial Wastes: Proceedings of the 21st Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1989. p 146-156. 5 fig, 1 tab, 8 ref.

Descriptors: *Activated carbon, *Chromium, *Model studies, *Wastewater treatment, Alkalinity, Chemical reactions, Hydrogen ion concentration, Oxidation-reduction potential.

A mechanistic model that incorporates the accumulation of hexavalent chromium onto activated carbon surfaces, the chemical reduction of hexavalent chromium to trivalent chromium by activated carbon surfaces and the regeneration of the chromium species to the hexavalent or trivalent state depending on the pH of the regenerant was developed. Data from column experiments showed that: (1) activated carbon may be used for the removal of hexavalent chromium from solutions with concentrations in the range of 250 mg/L to 300 mg/L; (2) concentrated trivalent solutions can be generated at acidic pH values; (3) the capacity of activated carbon increases significantly at acidic pH with the successive accumulation and regeneration cycles; (4) alkaline regeneration, on the other hand, results in loss of activity of activated carbon towards chromium accumulation; and (5) regeneration at high pH generates concentrated hexavalent chromium solutions, while regeneration at low pH results in chromium reduction. The mechanistic model predicts that: (1) at acidic pH an oxidation-reduction reaction occurs on the surface of activated carbon where Cr(VI) is reduced to Cr(III), and the activated carbon sites get oxidized resulting in increased sorption capacity; (2) the accumulation of Cr(VI) and Cr(III) species occurs simultaneously onto the carbon surfaces and is pH dependent; and (3) the regeneration at low or high pH recovers only Cr(III) or Cr(VI) species respectively leading to an incomplete recovery of all the chromium species retained on the surface of carbon. (See also W91-07139) (Author's abstract)
W91-07149

TREATMENT OF HAZARDOUS ORGANIC WASTES IN AN AERATED SUBMERGED FIXED FILM BIOLOGICAL REACTOR.
Kuwait Univ., Safat. Coll. of Engineering and Petroleum.
M. F. Hamoda, and M. F. Abd-el-bary.
IN: Hazardous and Industrial Wastes: Proceedings of the 21st Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1989. p 157-173. 8 fig, 1 tab, 13 ref. Environment Protection Council of the State of Kuwait grant EPC 002.

Descriptors: *Biofilm reactors, *Biological treatment, *Hazardous wastes, *Industrial wastes, *Wastewater treatment, Benzenes, Chemical oxygen demand, Microorganisms, Municipal wastewater, Nitrogen, Phenols, Phosphorus.

There has been an increasing interest in the biological fixed film treatment processes. However, studies on the application of fixed film processes to the treatment of industrial and hazardous wastes are limited. Stability and long retention of microorganisms in a fixed film process proved to be advantageous in municipal wastewater treatment, and is thought to be beneficial in improving the removal of toxic organics. After film development, a synthetic feed containing the targeted organic substrate was pumped into the reactors for a minimum period of two weeks until a steady state was reached. The synthetic feed composition was formulated from the organic substrates and the inorganic compounds so that the ratio of chemical oxygen demand:nitrogen:phosphorus was kept the same for all feed solutions used. Biofilm acclimation took a minimum of two weeks before the reactor was examined for substrate removal under steady state conditions. Compounds used were sugar, phenol, and nitrobenzene. It was shown that acclimated microbial populations could efficiently remove biodegradable toxic organics such as phenol and nitrobenzene in a fixed film reactor by an oxidative assimilation mechanism. Similar removal patterns were obtained in both combined organic and single organic substrate systems. The results provide a clear indication that heterogeneous microbial populations acclimated to a mixed toxic/nontoxic substrate system could utilize the toxic substrate in the presence of the nontoxic substrate. The results of this study have practical implications in the biological treatment of both industrial effluents and municipal wastewater containing toxic organic chemicals. (See also W91-07139) (Mertz-PTT)
W91-07150

KINETICS OF ORGANIC MATTER REMOVAL BY OZONE IN SEQUENTIAL BATCH REACTOR.
Ecole Polytechnique, Montreal (Quebec). Dept. of Civil Engineering.
R. Hausler, F. G. Briere, and P. Beron.
IN: Hazardous and Industrial Wastes: Proceedings of the 21st Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1989. p 174-181. 6 fig, 1 tab.

Descriptors: *Organic matter, *Ozonation, *Ozone, *Wastewater treatment, Disinfection, Hydrogen ion concentration, Kinetics, Oxidation, Sequential batch reactors, Sludge, Wastewater reactors.

Ozone has been used for pre and post oxidation when coliform concentrations in raw water are extremely high or when taste or odor problems mainly due to oxidation of algae by chlorine are present. Ozone has never been used in sewage treatment even though the main objective of water pollution control is to oxidize organic matter that would otherwise be oxidized in the receiving body of water, thus depleting oxygen concentration. Organic matter oxidation was investigated in a chemical sequential batch reactor with 7.5 L capacity. The quantity of ozone used to oxidize organic matter was computed by trapping excess O3 released in the air at the outlet of the reactor. Ozone oxidation of synthetic sewage was maximized by alternatively changing pH from an acid to an alkaline zone and from an alkaline to an acid zone. It was shown that ozone organic matter oxidation had the following advantages: less sludge production than standard chemical and biological treatments; effluent did not need disinfection; the treatment was not affected by toxic material; and the process was easily controlled. (See also W91-07139) (Mertz-PTT)
W91-07151

REMOVAL OF NICKEL IN THE PRESENCE OF EDTA (ETHYLENEDIAMINETETRAACETIC ACID).
Brown and Caldwell, Seattle, WA.
S. V. Arumugam, and S. K. Bhagat.
IN: Hazardous and Industrial Wastes: Proceedings of the 21st Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1989. p 182-204. 11 fig, 3 tab, 32 ref.

Descriptors: *Chemical precipitation, *Nickel, *Wastewater treatment, Anions, Chemical treatment, EDTA, Hydrogen ion concentration, Reaction time, Zeta potential.

Several processes have been identified and used to treat metal bearing wastewaters. The simplest is conventional chemical precipitation using caustic materials or lime. However, the efficiencies of heavy metals removal are affected by many factors. Experiments were performed to examine the effects of five independent variables, namely,

nickel concentration, pH, reaction time, iron, and EDTA (ethylenediaminetetraacetic acid) on the efficiency of nickel removal and the zeta potential of sludge particles as dependent variables. The linear regression analysis of the observed data indicated the effects of nickel concentration, pH, and EDTA are highly significant in affecting nickel removal. One interesting observation was that the addition of iron for coprecipitation did not enhance the nickel removal, which is a benefit in the reduction of sludge volume and overall treatment cost for nickel removal. The presence of EDTA greatly inhibits the nickel precipitation. The effect is greater when the EDTA to nickel ratio is >/= 1. Below this limit, a substantial removal of nickel could be achieved if the system is operated below pH 8. Reduction in nickel removal efficiency with increased concentration of EDTA and pH is due to the accumulation of excess anions at the solid-water interfacer resulting in an electrostatic repulsion for the increased stability of the suspensions. An important finding in this study is that the zeta potential could be directly correlated with the efficiency of nickel removal. Use of this correlation may lead to atomize the chemical precipitation treatment by employing an on-line zeta potential measuring device and to predict the nickel removal, saving time and money. (See also W91-07139) (Mertz-PTT)
W91-07152

OPERATIONS AND MONITORING OF LAND TREATMENT OF BIODEGRADABLE PETROLEUM WASTE.
J. Karmazyn, A. M. Mergenthaler, and L. Sherman.
IN: Hazardous and Industrial Wastes: Proceedings of the 21st Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1989. p 213-228. 4 fig, 5 tab, 1 ref.

Descriptors: *Biodegradation, *Hydrocarbons, *Land disposal, *Land treatment, *Oil wastes, *Waste disposal, *Waste treatment, Groundwater pollution, Monitoring, Runoff, Soil contamination.

Land treatment facilities must be sited, designed, and managed in a manner that restricts migration of waste constituents, enhances degradation and allows for ultimate closure in an environmentally safe manner that provides for future land use. The site studied consisted of 28.14 acres; 19.89 of those acres were used for land treatment activities. The land treatment unit was constructed by grading an L-shaped unit with a haul road in the approximate center of the property. The unit was graded so that the drainage was toward the haul road and to the north along the haul road. On the north end of the facility, two stormwater holding ponds were constructed to hold the treatment area rainfall runoff from a 25-year, 24-hour storm event. The perimeter of the L-shaped unit is surrounded with a soil berm, ranging from 1 foot to 3 feet and designed to restrict the runon/runoff at the land treatment unit. Petroleum and small amounts of organic wastes were received directly from trucks and deposited in the treatment zone. The waste was uniformly distributed over the treatment area using heavy equipment, incorporated into the soil using disk techniques, and plowed or disked frequently after application to mix the wastes thoroughly. A monitoring program was developed and implemented to evaluate treatment and potential vertical migration. The program included monitoring the soil pore water, and the surface and subsurface soils. By monitoring both short term application rates and long term accumulations, it has been possible to operate a land treatment facility in a temperate climate for over 6 years in a manner that protects human health and the environment. Waste application control in conjunction with immediate incorporation and mixing for the first week followed by weekly tilling optimizes the treatment process. Annual application of fertilizer further enhances the degradation. By timing fertilizer application with the end of the application year to enhance cover crop growth, it is possible to control wind erosion and promote treatment during what are normally considered dormant periods due to dropping temperatures. (See also W91-07139) (Mertz-PTT)
W91-07154

TRANSPORTABLE MODULAR INCINERATION: DIFFERENT MODES, DIFFERENT PURPOSES, DIFFERENT PERMIT REQUIREMENTS.
ENSCO Environmental Services, Inc., Fremont, CA.
For primary bibliographic entry see Field 5E.
W91-07157

REMOVAL OF IRON CYANIDE BY PHOTOLYSIS AND CHEMICAL OXIDATION.
Drexel Univ., Philadelphia, PA. Dept. of Environmental Studies.
M. D. Gurol, and J. H. Woodman.
IN: Hazardous and Industrial Wastes: Proceedings of the 21st Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1989. p 282-290. 6 fig, 14 ref.

Descriptors: *Cyanide, *Hazardous wastes, *Industrial wastes, *Metal-finishing wastes, *Oxidation, *Photolysis, *Waste treatment, Chlorine, Iron, Ozonation, Ozone, Ultraviolet light.

Cyanides are problematic end products of metal finishing, oil and steel processing and various other industries. The EPA regulates cyanide as a Priority Pollutant under Clean Water Act, and cyanide containing wastes are regulated under Resource Conservation and Recovery Act as hazardous wastes. The EPA has recently proposed a restriction on the land disposal of untreated cyanide wastes. The effectiveness of three treatment techniques for oxidation of iron complexes of cyanide were compared: photolysis by ultraviolet light; ultraviolet radiation with chlorine; and ultraviolet radiation with ozone. The techniques were tested on synthetic potassium ferric cyanide. Results showed that ultraviolet radiation is essential to free cyanide for oxidation by breaking the iron-cyanide bond. Ultraviolet light at sufficient intensity can oxidize free cyanide via generation of hydroxyl radicals from water. Ultraviolet/chlorination is effective in oxidizing iron-complexed cyanide; however, chlorine is decomposed by ultraviolet light into species inactive with respect to oxidizing cyanide. However, a specially designed and operated reactor can eliminate this undesirable side reaction. Ultraviolet/ozonation seems to be a better treatment or oxidation of iron-complexed cyanide, since ozone is decomposed by ultraviolet light into hydroxyl radicals that are quite effective in oxidizing cyanide. Ultraviolet light/chlorination might prove to be a cost-effective process for wastes that contain a mixture of simple cyanides amenable to chlorine oxidation alone, and stable metal complexes of cyanide that can be treated by ultraviolet/chlorination. (See also W91-07139) (Mertz-PTT)
W91-07159

REMOVAL OF ACETONE, PYRROLE, AND PROPIONITRILE USING BATCH BIOLOGICAL REACTORS.
Tennessee Technological Univ., Cookeville.
S. Miles, R. B. Bustamante, and W. P. Bonner.
IN: Hazardous and Industrial Wastes: Proceedings of the 21st Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1989. p 291-303. 16 fig, 4 tab, 4 ref.

Descriptors: *Acetone, *Biological treatment, *Hydrocarbons, *Propionitrile, *Pyrrole, *Wastewater treatment, Chemical oxygen demand, Fluidized beds, Gas chromatography, Wastewater reactors.

The Department of Energy is sponsoring research that involves hydroretorting of eastern U.S. oil shale in a pressurized, fluidized bed. Preliminary batch studies for the biological treatment process have focused on three organic components of the wastewater: acetone, propionitrile, and pyrrole. Synthetic wastes containing acetone, pyrrole, and propionitrile were shown to be treatable, in batch biological reactors, both individually and in combinations of two and three substrates. The chemical oxygen demand values of the various wastes were reduced to low levels of 20-40 mg/L, indicating that the substrates were being completely metabolized. Gas chromatography analyses of double substrate experiments verified these findings. Sterile control experiments revealed that negligible chemical oxygen demand reduction was achieved by air stripping alone and that the primary mechanism of substrate removal was biological metabolism. Simultaneous removal of substrates was achieved in all double substrate experiments. Acetone and propionitrile were removed at the same rates while pyrrole was metabolized more slowly, requiring longer treatment time. The combinations of acetone/propionitrile and acetone/pyrrole did not take more time than the corresponding lower rate, single substrate experiment, but the removal of propionitrile and pyrrole together required longer than the removal of either substrate alone. The metabolism of the three substrates together was, similarly, accomplished in greater time than was necessary for either single substrate. Experiments that involved two substrates revealed that all combinations of substrates were removed simultaneously, not sequentially. (See also W91-07139) (Mertz-PTT)
W91-07160

CASE HISTORY OF A MAJOR TURNKEY EXPANSION OF AN OPERATING INDUSTRIAL WASTEWATER TREATMENT PLANT.
Weston Services, Inc., West Chester, PA.
R. T. Salacka, R. G. Thompson, J. W. Hammond, A. S. Shah, and E. J. Lorenz.
IN: Hazardous and Industrial Wastes: Proceedings of the 21st Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1989. p 304-313. 2 fig.

Descriptors: *Chromium, *Fluorides, *Heavy metals, *Industrial wastes, *Lead, *Wastewater facilities, *Wastewater treatment, Construction, Construction methods, Facilities management, New York.

In 1985, a cathode ray tube manufacturing plant in Horseheads, NY was constructed to manufacture 19 and 20 inch tubes. Wastewaters generated in the manufacturing areas were treated in an industrial wastewater treatment plant with a capacity of 660,000 gallons/day; it had two permitted discharges. The primary discharge was 506,000 gallons/day of treated wastewaters originally containing Cr, Pb, and other heavy metals. This was discharged to a nearby surface stream under a National Pollutant Discharge Elimination System (NPDES) permit. Treated wastewaters originally containing fluoride (HF) comprised the secondary discharge of 164,000 gallons/day to the local county treatment plant. After testing of Phase I operations of the cathode ray tube manufacturing wastewater treatment facility, Phase II construction began. The facility was designed for increased hydraulic capacity using the same treatment technology as the existing facility. Design and operational experience combined with design/construction considerations made for a smooth transition into the Phase II facilities. Key on-site staff with the ability to anticipate process problems during construction and the ability to plan for them ahead of time was a major factor to the success of the project. The constant assistance of the plant operators made all the planned implementation tasks go according to schedule. (See also W91-07139) (Mertz-PTT)
W91-07161

PRETREATMENT TO MEET THE EPA'S ORGANIC CHEMICALS, PLASTICS AND SYNTHETIC FIBERS EFFLUENT GUIDELINES.
BCM Engineers, Inc., Plymouth Meeting, PA.
A. F. Yen, and S. H. Abrams.
IN: Hazardous and Industrial Wastes: Proceedings of the 21st Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1989. p 314-328. 3 fig, 1 tab.

Descriptors: *Chemical wastes, *Industrial wastes, *Pretreatment of wastewater, *Waste treatment, *Wastewater treatment, Air stripping, Biological treatment, Flocculation, Fractionation, Oxidation, Recycling, Regulations, Resins, Solvent extraction, Waste management, Waste recovery.

The EPA promulgated effluent guidelines for organic chemicals, plastics, and synthetic fibers industry category in late 1987. Pretreatment of organic chemicals, plastics, and synthetic fibers wastewaters prior to discharge into a publicowned treatment works is now required. The pretreatment standards are very stringent, and the compliance deadline, extremely tight. Many of the standards promulgated for 47 pollutants are below 500 micrograms/L. For some pollutants, the standards are as low as 19 micrograms/L. A large-size chemical company that manufactures over 900 organic chemical products is currently in the preliminary engineering phase to meet new EPA requirements. The projects include the following tasks: wastewater characterization; assessment of alternative compliance strategies; source control evaluation; treatability studies, including bench-scale and pilot-scale testings; and process design. The chemical company has specific policies encouraging waste minimization and source control, as well as dedication to meeting EPA regulations. Source control techniques being evaluated include: material recovery and recycle; chemical substitutions; employment of dry processes; containment of material transfer stations; segregation of wastes; and good housekeeping. Treatment technologies, that can be used at sources or at the end-of-pipe, were also evaluated. These included: stripping, solvent extraction, foam fractionation, ultraviolet/peroxide oxidation, carbon adsorption, resin adsorption, and biological oxidation. The pretreatment step is to remove suspended solids. Processes are chemical flocculation using a ferric salt, gravity settling and filtration. Preliminary indications are that the sludge generation rates are excessive and that the sludge may be a hazardous waste, thus making offset disposal expensive. Alternative processes are being tested on a bench-scale, including dissolved air flotation and microfiltration. (See also W91-07139) (Mertz-PTT)
W91-07162

COMPARISON OF BIOLOGICAL SOLIDS PRODUCTION DURING ACTIVATED SLUDGE TREATMENT WHEN EITHER AMMONIA OR NITRATE IS THE SUPPLEMENTAL NITROGEN SOURCE.
J. J. Delaney, C. A. Cole, R. F. Unz, and C. Gray.
IN: Hazardous and Industrial Wastes: Proceeding of the 21st Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1989. p331-343. 4 fig, 5 tab, 15 ref.

*Industrial wastes, *Biological wastwater treatment, *Nitrogen, Ammonia, Nitrates, Activated sludge, *Wastewater treatment, Microorganisms, Bacteria, Oxygen demand.

Activated sludge treatment of biodegradable industrial wastes is a widely acceptable practice. Often these wastes contain large amounts of carbonaceous matter but very little nitrogen. In these situations a supplemental nitrogen must be added to the waste stream to ensure a proper elemental balance to support activated sludge bacteria. Ammonia is generally employed as a nitrogen supplement. The literature indicates that nitrate may also be used. A continuous flow completely mixed bench top activated sludge treatment system with cellular recycle was employed to treat a synthetic waste. The study was conducted in two phases; an ammonia phase during which NH3 was the available form of nitrogen provided in the synthetic waste; and a nitrate phase during which NO3(-) was the available form of nitrogen. Results showed that heterotrophic organisms employed in the biological treatment of wastewater containing carbonaceous substrate were capable of using nitrate-nitrogen for metabolic purposes in lieu of ammonia-nitrogen. The selection of nitrate instead of ammonia as the supplemental form of nitrogen supplied to heterotrophic organisms treating nitrogen deficient wastewater resulted in approximately one half of the biological solids production as indicated by the coefficient of cell yield. The effluent volatile suspended solids and biological oxygen deman concentrations were generally greater when nitrate served as the supplemental form of nitrogen supplied to a nitrogen deficent waste. Effluent chemical oxygen demand, however, was lower when nitrate was the supplemental nitrogen source. The use of nitrate as a supplement for nitrogen deficient industrial wastewater may reduce chemical requirements for pH adjustment and eliminate oxygen demand associated with biological nitrification of ammonia. (See also W90-07139) (Mertz-PTT).
W91-07163

REMOVAL AND DEGRADATION OF TNT IN A SEMICONTINUOUS ACTIVATED SLUDGE SYSTEM.
Carpenter Environmental Associates, Inc., Northvale, NJ.
B. A. Bell, and W. D. Burrows.
IN: Hazardous and Industrial Wastes: Proceedings of the 21st Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1989. p 344-356. 3 fig, 2 tab, 21 ref.

Descriptors: *Activated sludge process, *Degradation products, *Explosives, *Hazardous wastes, *Trinitrotoluene, *Wastewater treatment, Hazardous materials, Industrial wastes, Organic loading, Waste load.

The manufacture and production of explosives for commercial and military applications constitute a major industry in the U.S. Wastewaters generated by this industry are of concern due to their nature, questionable biodegradability, and toxicity to plants, animals, and humans. Concern also stems from the explosive properties of the wastes generated, thus imposing numerous treatment, handling and disposal problems. During a study of the treatment of explosive bearing wastewaters in a semicontinuous activated sludge treatment system, it was noted that complete removal of 2,4,6-trinitrotoluene (TNT) was achieved. As a result, investigations were carried out to identify and quantify metabolic degradation products of TNT in the effluent and sludge, as well as to determine the rate of TNT degradation. Results showed that removal of TNT was essentially complete throughout the study. No metabolites of TNT were detected in the effluent, sludge or supernatant from simulated landfilled sludge. TNT removal rate was shown to be a function of available organic load. (See also W91-07139) (Mertz-PTT)
W91-07164

EFFECT OF THE HYDRAULIC REGIME ON THE GRANULE SIZE DISTRIBUTION IN AN UPFLOW ANAEROBIC REACTOR.
Ecole Polytechnique, Montreal (Quebec).
Y. Arcand, M. Desrochers, C. Chavarie, and S. R. Guiot.
IN: Hazardous and Industrial Wastes: Proceedings of the 21st Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1989. p 357-370. 4 fig, 2 tab, 13 ref.

Descriptors: *Anaerobic digestion, *Particle size, *Sludge bed, *Wastewater treatment, Biological wastewater treatment, Biomass, Growth rates, Hydraulic properties, Microorganisms, Upflow anaerobic reactors, Waste load.

The upflow anaerobic sludge bed and filter system is based on the upflow anaerobic sludge blanket concept. The main advantage of upflow anaerobic sludge blanket-like reactors is their ability to accumulate a high amount of biomass compared to other types of bioreactors. The key to the success of the upflow anaerobic sludge blanket configuration is the ability of bacterial cells to aggregate into dense particles called granules when grown under an upflow feed. The upflow liquid velocity is a major factor which might influence the granulation process and the granule size. The upflow liquid velocity is an operational variable that can be easily manipulated at industrial scale. The equilibrium granule size distribution of an upflow anaerobic sludge bed and filter reactor seems to be a constant competition between five different phenomenons. On the first step, the biomass increases because of the microorganisms' natural growth that is a clear function of the feed composition and specific loading rate. Biological variables such as the populations involved and their specific growth rate are also influenced by the liquid upflow velocity because a more turbulent hydraulic regime generally lowers the mass transfer resistance. This allows better substrate availability, thus increasing the local specific growth rate. Increasing the liquid velocity in the bed has two important drawbacks: wash out of the smaller particles; and surface abrasion of bigger particles. As the granule increases in size, the growth should eventually die down because of mass transfer limitation in the center of the granule. This will form a hollow core, weakening the granule's structure and acting as a gas trap. In a low turbulence bed, the granule would eventually float and be lost to the effluent. In a more turbulent bed, the granule should break up and the cycle will start all over again. (See also W91-07139) (Mertz-PTT)
W91-07165

PERFORMANCE AND KINETICS OF AN AERATED/FACULTATIVE LAGOON SUSPENDED-GROWTH BIOLOGICAL TREATMENT SYSTEM FOR HIGH STRENGTH INDUSTRIAL WASTE STABILIZATION.
T. J. Muirhead.
IN: Hazardous and Industrial Wastes: Proceedings of the 21st Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1989. p 371-385. 14 fig, 5 tab, 19 ref.

Descriptors: *Aerated lagoons, *Biological wastewater treatment, *Industrial wastes, *Wastewater lagoons, *Wastewater treatment, Activated sludge process, Biological treatment, Biomass, Colorado, Growth kinetics, Kinetics, Microorganisms.

A Colorado-based biotechnology company treats their industrial waste on site at their wastewater treatment plant. The plant primarily consists of two efficient biological treatment systems: an 8.4 million gallon aerated/facultative lagoon system and a 6.2 million gallon conventional activated sludge system (aeration basin), complete with flow and strength equalization basin, chemical/nutrient blend tank, sludge reaeration, sludge return or waste, and settling pond. Combined effluent from the second-stage settling pond and first-stage sedimentation basin is disinfected with chlorine and discharged to the Little Thompson River. The unusual treatment efficiency experienced at this wastewater treatment facility, for high strength industrial waste stabilization, is derived from the innovative treatment process and unique operation, performance, and process stream flexibility of the aerated/facultative lagoon. The performance and kinetics of the aerated/facultative lagoon suspended-growth biological treatment system were evaluated. It was found that the innovative use of the aerated lagoon is essential in the waste treatment process. Process stream flexibility, large tank volume, adequate aeration, sufficient nutrients, long mean cell residence time, high buffering capacity, and healthy-recalcitrant microbial biomass significantly contribute to its excellent efficiency in high strength industrial waste stabilization. The biological kinetic coefficients appeared reasonable, but did not accurately predict effluent microorganisms and substrate concentrations. High strength soluble industrial waste stabilization using aerated/facultative lagoons are more appropriately applied to a dynamic, higher-order removal rate mathematical model. (See also W91-07139) (Mertz-PTT)
W91-07166

COMPOSTING OF EXPLOSIVES AND PROPELLANT CONTAMINATED SEDIMENTS.
Weston (Roy F.), Inc., West Chester, PA.
R. T. Williams, P. S. Ziegenfuss, G. B. Mohrman, and W. E. Sisk.
IN: Hazardous and Industrial Wastes: Proceedings of the 21st Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1989. p 599-611. 4 fig, 1 tab, 11 ref. U.S. Army contract purchase order No. DAAK11-85-D-0007.

Descriptors: *Composting, *Explosives, *Hazardous wastes, *Trinitrotoluene, *Waste disposal, *Waste treatment, Compost, Degradation, Degradation products, Hazardous materials, Soil contamination, Temperature effects.

Two field-scale demonstrations were conducted to investigate composting as a technology for remediating explosives and propellant contaminated sediments. Test sediments at the Louisiana Army Ammunition Plant contained approximately 76,000 parts per million of total explosives, including TNT (2,4,6,-trinitrotoluene) (66% of total explosive), 25% RDX (hexahydro-1,3,5-trinitro-1,3,5-triazine), 9% HMX (octahydro-1,3,5,7-tetranitro-1,3,5,7-tetraazocine), and 0.3% tetryl. The mixture that was composed consisted of straw/horse manure, alfalfa, horse feed, and sediment. Two 12 cubic yard piles were constructed, one was maintained at approximately 35 C and the second at approximately 55 C. After 22 weeks, total explosives were reduced by 99% (from 17,872 to 74 parts per million) in the thermophilic pile (55 C). Transformation products peaked in concentration at approximately 20 days and subsequently fell to near detection limits. At the Badger Army Ammunition Plant, test sediments contained approximately 18,000 parts per million of nitrocellulose. Nitrocellulose was reduced from 13,086 parts per million to 16 parts per million after 101 days in a thermophilic pile. (See also W91-07139) (Author's abstract)
W91-07180

TRANSFORMATION KINETICS OF HALOGENATED ALIPHATIC COMPOUNDS UNDER AEROBIC CONDITIONS.
Johns Hopkins Univ., Baltimore, MD. Dept. of Geography and Environmental Engineering.
For primary bibliographic entry see Field 2K.
W91-07186

REPORT TO CONGRESS: INDIAN WASTEWATER TREATMENT, NEEDS AND ASSISTANCE.
Environmental Protection Agency, Washington, DC. Office of Municipal Pollution Control.
For primary bibliographic entry see Field 5G.
W91-07193

FUNDAMENTAL ASPECTS OF SELENIUM REMOVAL BY HARZA PROCESS.
Harza Engineering Co., Chicago, IL.
May 1989. 18p, 4 fig, 2 ref, append. Bureau of Reclamation Contract No. 7-CS-20-05170.

Descriptors: *California, *Harza Process, *Selenium, *Wastewater treatment, Adsorption, Hazardous wastes, Heavy metals, Industrial wastewater, Iron, Panoche Drainage District, Physical treatment.

In 1986 Harza Engineering Company received a U.S. patent for a process that removes toxic heavy metals from wastewaters. That year this process was applied in a pilot plant study to the drainage water of the Panoche Drainage District, California, and the results were promising, with over 90% removal of selenium. The current study was undertaken to determine the mechanism by which selenium is removed and the species formed on the iron surface to effect this removal. The process involves passing the wastewater through an activated bed of iron filings at a controlled rate. The investigators believe, to the best of their ability to determine, that selenium is removed by chemical adsorption on iron oxyhydroxide surfaces at an orange-brown layer of iron filings where drainage water enters the column. Prior to the formation of the oxyhydroxide layer, selenium can be removed throughout the iron filing bed by physical adsorption. Several analytical techniques to determine the surface species on the iron filings were unsuccessful. These techniques included Diffuse Reflectance--and Cylindrical Internal Reflectance--Fourier Transform Infrared spectroscopy and Raman spectroscopy. (Author's abstract)
W91-07226

SCREENINGS AND GRIT IN SEWAGE: REMOVAL, TREATMENT AND DISPOSAL. PHASE 3: STORM WATER OVERFLOWS AND PUMPING STATIONS.
J. M. Sidwick.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-196471. Price codes: A13 in paper copy, A01 in microfiche. Technical Note 132, 1988. 50p, 3 fig, 2 tab, 129 ref, append.

Descriptors: *Grit chambers, *Pumping plants, *Screens, *Waste disposal, *Wastewater treatment, Costs, Overflow channels, Storm-overflow sewers.

This is a report on Phase 3 of CIRIA Research Project 329, which studies the problems experienced with grit and screenings in sewage upstream from a treatment works inlet, and more specifically, to the problems experienced at, or caused by, storm sewage overflows (SSOs) and in-sewer pumping stations. The overall objectives of the study were to: (1) define the extent of the problems arising from inadequate separation, removal, treatment and disposal of screenings and grit at sewage treatment works; (2) estimate the consequential overall cost of such inadequate separation, removal, treatment and disposal of screenings and grit; (3) assess the requirements for screenings and grit separation, removal, treatment and disposal at sewage treatment works in the United Kingdom; (4) examine in detail the various methods available for screenings and grit removal, separation, treatment and disposal, and ascertain their effectiveness; (5) determine where improvements can be made; (6) make recommendations on identified improvements, together with an indication of the likely capital and recurring costs; and (7) make recommendations for the water industry on the type and performance of screenings and grit separation plant for given duty requirements. Principal recommendations include: (1) screening at pumping stations should be avoided if possible; (2) since energy requirements can be significantly increased as a result of ragging of impellers, it is recommended that frequent checks on the cleanliness of impellers is made during operational visits; (3) where large objects could cause blockage of pumps or rising mains are expected at existing small pumping stations, simple basket screens are preferred; (4) the need for grit removal at new pumping stations should be eliminated by good design practices; (5) screening at SSOs should be avoided if possible. The discharge of screenings with overflowing storm sewage should be kept to a minimum by obtaining the best screenings classification possible through good SSO design practice; (6) the installation of medium-bar screens at SSOs is not recommended except in situations of marginal environmental sensitivity where some degree of screening is judged to be desirable; (7) only in situations of extreme environmental sensitivity should the installation of fine screens be considered; and (8) grit removal at SSOs is not normally necessary and, therefore, is not recommended. (Lantz-PTT)
W91-07248

INFLUENCE OF THE GLYCOLIPID-PRODUCING BACTERIUM RHODOCOCCUS ERYTHROPOLIS ON THE DEGRADATION OF A HYDROCARBON MIXTURE BY AN ORIGINAL SOIL POPULATION.
Technische Univ. Braunschweig (Germany, F.R.). Inst. fuer Biochemie und Biotechnologie.
For primary bibliographic entry see Field 5G.
W91-07376

ANAEROBIC DEGRADATION OF PHENOL USING AN ACCLIMATED MIXED CULTURE.
Indian Inst. of Tech., New Delhi. Biochemical Engineering Research Centre.
R. Satsangee, and P. Ghosh.
Applied Microbiology and Biotechnology AMBIDG, Vol. 34, No. 1, p 127-130, 1990. 5 fig, 1 tab, 12 ref.

Descriptors: *Anaerobic digestion, *Biodegradation, *Methanogenesis, *Microbial degradation, *Phenols, *Wastewater treatment, Acetates, Acetic acid, Carbon, Glucose, Industrial wastes, Methane, Sludge.

Conventional methods of treating phenolic effluents lead to secondary effluent problems. Therefore, anaerobic methanogenesis of phenol using mixed cultures derived from cow dung and municipal sewage sludge and adapted to phenol was studied in batch reactors. The phenol degradation rate depended on the period in which the culture was acclimated to phenol. Stoichiometric calculation showed that about 55% of the carbon present in phenol was available in the form of methane gas. The rate of phenol consumption was higher in the absence of glucose; hardly any consumption of phenol was observed in the presence of 20 g/L glucose, indicating interference by glucose of the uptake of phenol. Consumption of both phenol and acetic acid was observed when an acetate-adapted culture was used. In coal conversion wastewaters, the dihydroxyphenols catechol and resorcinol are present together with phenol. The rates of catechol and resorcinol degradation were not affected by the presence of phenol, although phenol consumption in the mixture took longer than when it was the sole carbon source. (Doria-PTT)
W91-07377

DEGRADATION OF OILY SLUDGE FROM A FLOTATION UNIT BY FREE AND IMMOBILIZED MICROORGANISMS.
Muenster Univ. (Germany, F.R.). Inst. fuer Mikrobiologie.
S. H. Omar, U. Budecker, and H.-J. Rehm.
Applied Microbiology and Biotechnology AMBIDG, Vol. 34, No. 2, p 259-263, November 1990. 4 fig, 2 tab, 32 ref.

Descriptors: *Biodegradation, *Flotation, *Hydrocarbons, *Microbial degradation, *Oil wastes, *Wastewater treatment, Acidity, Clays, Culturing techniques, Fungi, Groundwater pollution, Oil pollution, Soil contamination.

The degradation rate of hydrocarbons in oily sludge obtained from a flotation unit by free and immobilized cells was investigated in shaking flasks and in a stirred tank reactor. For the biodegradation of 3.3% hydrocarbons, free cells and cells immobilized on granular clay were used. Free cells needed 7-8 weeks to use 30% of the hydrocarbons, whereas with immobilized cells the same result was obtained after only 3-4 weeks. In shaken flasks with high hydrocarbon concentrations (8%), immobilized Candida parapsilosis degraded 90% of the hydrocarbons in the oily sludge within 3 weeks, while free cells degraded only 27.5% in the same period. In degradation experiments with a bioreactor, free and immobilized cells of the isolate ISO-OS BU 20 showed better results compared to cultures in shaken flasks due to better aeration and mixing. Free cells degraded 50% of the 5% hydrocarbon-containing oily sludge in 7 weeks, whereas immobilized cells gave the same result after only 4 weeks. (Author's abstract)
W91-07378

MECHANISM OF CADMIUM UPTAKE BY ACTIVATED SLUDGE.
New Jersey Inst. of Tech., Newark. Biotechnology Research Group.
R. Gourdon, E. Rus, S. Bhende, and S. S. Sofer.
Applied Microbiology and Biotechnology AMBIDG, Vol. 34, No. 2, p 274-278, November 1990. 1 fig, 4 tab, 17 ref.

Descriptors: *Activated sludge, *Adsorption, *Cadmium, *Heavy metals, *Metabolism, *Wastewater treatment, Isotherms, Nutrients, Proteins, Respiration, Temperature, Toxicity, Ultraviolet radiation.

The significance of metabolic activity in cadmium uptake by unacclimated activated sludge was studied. Below 30 mg/L cadmium in solution, biosorption was found to follow the Freundlich isotherm, which is the most common pattern for physicochemical adsorption. More than 95% of total cadmium uptake was achieved within 5 min metal-sludge contact time. Biosorption increased strongly when the initial cadmium concentration in solution was raised from 10 to 100 mg/L, whereas in the same concentration range the metabolic activity of the sludge, as measured by respiratory activity and extracellular protein production, was very significantly inhibited. The addition of nutrients at low but significant levels failed to increase cadmium uptake in 2 h contact time, while in 24 h the

addition of nutrients caused the biosorption to increase by only 5% to 10% without any significant growth of the biomass. Biosorption was found to increase with temperature between 5 C and 40 C, in correlation with an increase in the metabolic activity of the sludge. Pretreatment of the sludge with metabolic inhibitors (NaN3 and UV rays) appeared to cause only a very slight decrease (5% to 10%) of biosorption. These results suggest that metabolic uptake of cadmium was low and that adsorption to the surface of the cells was the major mechanism of uptake. (Author's abstract)
W91-07379

UV EFFECT ON WASTEWATER.
Hazen and Sawyer, Upper Saddle River, NJ.
R. J. Fahey.
Water Engineering and Management WENMD2, Vol. 137, No. 12, p 15-18, December 1990. 1 fig, 1 tab.

Descriptors: *Disinfection, *Ultraviolet radiation, *Wastewater treatment, Bacteria, Chlorination, Cost analysis, Iron, Maintenance, Phenols, Regulations, Suspended solids.

In the past 5 years, the use of ultraviolet (UV) radiation as a means of disinfection for treating wastewater effluent has increased dramatically. A UV system consists of a network of ultraviolet lamps mounted in a frame. Typically, a wavelength of 2,537 Angstroms is used. Unlike chlorination, which may require subsequent dechlorination or reaeration, UV is generally the final process in the treatment plant. UV dosages depend on wastewater characteristics. Suspended solids tend to shield bacteria from radiation, and certain compounds, such as phenols and iron salts, absorb UV radiation. Only a few seconds of exposure of treated effluent to a properly designed UV system are required to achieve reductions in microorganisms below the requirements of most regulatory agencies. The UV disinfection system can be designed in two ways: open channel or enclosed system. While both systems perform adequately, open channel systems are easier to monitor and maintain; however, maintaining a constant water level is critical in an open channel system. In both design systems, continuous monitoring of the lamps is crucial. The open channel system at the Northwest Bergen County Utilities Authority wastewater treatment plant in New Jersey consists of four banks of lamps, two in each channel. The main cost for the system maintenance is lamp costs. Personnel costs are less for a UV system than for a chlorination system. (Doria-PTT)
W91-07413

COLD WEATHER DECHLORINATION.
Freese and Nichols, Inc., Fort Worth, TX.
D. W. Sloan.
Water Engineering and Management WENMD2, Vol. 137, No. 12, p 21-24, December 1990. 2 fig.

Descriptors: *Dechlorination, *Sulfur dioxide, *Wastewater treatment, Cold resistance, Costs, Temperature, Wastewater treatment plants.

Many wastewater treatment plants are turning to sulfur dioxide for dechlorination because of its relatively low cost and its handling characteristics. However, during the winter months in most parts of the United States, sulfur dioxide must be either heated or pressurized before it can be fed. Several design alternatives can achieve the goal of elevating the pressure in the SO2 storage vessel above the vapor pressure resulting from the ambient temperature. These include nitrogen padding, dry air padding, compressed SO2 from an adjacent source, heating and insulation, or indoor storage. The alternative is determined in part by the type of storage vessel and delivery provided at the facility. These principles are illustrated by the example of the Trinity River Authority's Central Wastewater Treatment Plant in the Dallas/Fort Worth area. The plant ultimately selected a combination of alternatives built around a stationary tank insulated and equipped with heating pads designed to maintain system temperature at 70 F. This resulted in a flexible system capable of operating under a diverse set of operating conditions. (Doria-PTT)
W91-07414

WASTEWATER TREATMENT BY IMMOBILIZED CELLS.
CRC Press, Inc., Boca Raton, Florida. 1990. 281p. Edited by R. D. Tyagi and Kannan Vembu.

Descriptors: *Biofilm reactors, *Biofilms, *Biological wastewater treatment, *Immobilized cells, *Microbial degradation, *Microorganisms, *Wastewater treatment, Adsorption, Aggregates, Algae, Analytical methods, Biomass, Biotransformation, Cyanobacteria, Laboratory methods, Microbiological studies, Morphology, Polymers, Toxic wastes.

Immobilized cell processes for wastewater treatment have only recently been intensively studied and applied. Essential information on the feasibility of various immobilization methods has been reviewed and examined with special reference to wastewater treatment. Included are the suitability of various supports (inorganic and organic), techniques used for microbial attachment (involving experimental procedures), factors affecting affinity for the support, strength of fixation, nature of polymers, role of radical groups, properties of attached microorganisms, effects of carriers on settling properties of biomass, characteristics of biofilm on carriers, and changes in cell metabolism as a result of immobilization. The morphologies for identification of immobilized cells, the methods of identification of structure and composition of microbial aggregates, and analytical methods for the estimate of biomass in the presence of carriers are discussed. Applications of immobilized cells to toxic wasted, anaerobic and aerobic systems, and operational criteria for different wastes are specified. The results of immobilized microalgae and cyanobacteria for wastewater treatment are reported and their future prospects are highlighted. Various immobilized cell bioreactor configurations have been critically reviewed with respect to design and granulation process including the topics of: biomass retention, resistance to washout, diffusional resistances, response to toxic shocks, theoretical aspects of hydrodynamic characteristics, start-up and steady-state processes, selection of support particles, particle size and active biomass, head loss considerations, surface area, reactor liquid velocity, hydraulic retention time aerobic versus anaerobic systems, temperature and substrate concentration effects, metabolic interspecies transfer, stability, suspended solids and microbial film interactions, solids residence time requirements, and operational issues. (See W91-07455 thru W91-07464) (VerNooy-PTT)
W91-07454

PHYSICOCHEMICAL ASPECTS OF CELL ADSORPTION.
Universite de Technologie de Compiegne (France). Dept. of Chemical Engineering.
N. Cochet, J. M. Lebeault, and M. A. Vijayalakshmi.
IN: Wastewater Treatment by Immobilized Cells. CRC Press, Inc., Boca Raton, Florida. 1990. p 1-28. 11 fig, 11 tab, 43 ref.

Descriptors: *Adsorption, *Biofilms, *Biological wastewater treatment, *Biotechnology, *Immobilized cells, *Microorganisms, *Physicochemical properties, *Wastewater treatment, Adsorbents, Biotransformation, Bonding, Carbohydrates, Clays, Metabolism, Microbial degradation, Microbiological studies, Morphology, Polymers, Porous media.

The adsorption and immobilization of cells onto solid surfaces is a phenomenon omnipresent in nature, (eg, the fixation of microorganisms, on soil particles, on sand particles or rocks, etc). Adsorption of cells depends on surface properties of both the cell surface and the support (e.g., available surface, porosity and charge) to which these cells adhere. The stability of cell retention depends on several properties since cell leakage is often noticed while varying the pH, ionic strength, or even the dynamics of ion exchange conditions by varying the flow of the liquid medium. The three major mechanisms responsible for cell attachment to inorganic support are electrostatic interactions, partial covalent bonding formed via replacement of hydroxyl groups on inorganic surfaces, and covalent bond formed between ligands on the cell surface and organic groups, grafted to an inorganic surface. Organic carriers studied include crosslinked pectate and carrageenan, with the addition of inorganic metal ions to greatly increase the support capacity for cell adsorption. Starch rich effluents from the food industry were studied with both organic (i.e., crosslinked pectate with iron and polypropylene) and inorganic (ceramic kaolinic clay) supports for whole cell immobilization. The adsorption characteristics of the supports were studied, including affinity for the support of cells, strength of fixation, influence of ionic strength of the cell adsorption, and oxygen uptake of cells. Adhesion phenomenon appears as an interesting approach for biotechnological applications, and wastewater treatment principally. Low price of the supports, efficacy, and easy utilization are the main advantages if it is compared with other immobilization techniques. Laboratory studies showed increased cell metabolism when the cells are involved in an immobilized system. (See also W91-07447) (VerNooy-PTT)
W91-07455

ADSORPTION AND ATTACHMENT OF MICROORGANISMS TO SOLID SUPPORTS.
Massey Univ., Palmerston North (New Zealand). Dept. of Biotechnology.
S. M. R. Bhamidimarri.
IN: Wastewater Treatment by Immobilized Cells. CRC Press, Inc., Boca Raton, Florida. 1990. p 29-43. 4 fig, 51 ref, append.

Descriptors: *Adsorption, *Biofilm reactors, *Biofilms, *Biological wastewater treatment, *Biotechnology, *Immobilized cells, *Microorganisms, *Wastewater treatment, Adsorption kinetics, Bacterial physiology, Biotransformation, Interfaces, Microbial degradation, Microbiological studies, Morphology, Particulate matter, Physicochemical properties, Reviews.

The importance of microbial adhesion to surfaces has been increasingly recognized in biochemical and wastewater treatment processes, in which it plays a beneficial role. Adsorption mechanisms operate in the nonselective concentration of microorganisms at interfaces occurring in aqueous systems. A number of forces are responsible for the microbial movement towards or away from the substratum, including short-range forces, long-range forces, and interfacial reactions. The most accepted theory involving interaction of small particles at close separations is referred to as the DLVO theory of colloidal stability, although its ability to describe particle deposition is far from adequate even for idealized systems. The most commonly employed configurations of immobilized cell reactors for wastewater treatment are the biofilm reactors. Although there is a large number of reports on steady-state performance of such immobilized cell reactors in the literature, quantitative studies on the initial microbial adsorption and attachment have been limited. Current knowledge concerning adsorption kinetics, development of an adsorption isotherm, and the effect of environmental factors on microbial adsorption are reviewed. Although the initial interactions between the solid surfaces and microorganisms are dictated by physicochemical phenomena such as pH, nutrient concentration, and hydrodynamics; the attachment of adsorbed microorganisms involves a variety of biological processes. A variety of factors that contribute to the bacterial attachment process has been identified, including extracellular adhesions and holdfasts, fimbriae and flagella, and lipopolysaccharides in the cell envelope. The successful design, start-up, and operation of adsorbed and attached cell systems in wastewater and biotechnological processes requires a thorough understanding of the mechanisms of adsorption and attachment of microorganisms. (See also W91-07454) (VerNooy-PTT)
W91-07456

ENTRAPMENT OF MICROBIAL CELLS FOR WASTEWATER TREATMENT.
Hawaii Univ. at Manoa, Honolulu. Dept. of Agricultural Engineering.
P. Y. Yang, and M. L. Wang.
IN: Wastewater Treatment by Immobilized Cells. CRC Press, Inc., Boca Raton, Florida. 1990. p 45-77. 19 fig, 4 tab, 54 ref.

Descriptors: *Biofilms, *Biological wastewater treatment, *Biotechnology, *Immobilized cells, *Microorganisms, *Phenols, *Wastewater treatment, Adsorption, Biosynthesis, Biotransformation, Gels, Microbial degradation, Microbiological studies, Polymers, Reviews.

No general ideal immobilization method is applicable to all types of cells. Therefore, it is necessary to select suitable methods and conditions for immobilization of each type of cell. Entrapping is the most extensively investigated immobilization method and the enclosure of a cell within a gel structure is one of the least destructive immobilization methods. Gel polymers, including alginate, carrageenan cellulose triacetate, and polyacrylamide, have been widely used as carriers. Immobilized cell systems have been increasingly used in biological wastewater treatment. The use of immobilized cells for methane production, hydrogen production nitrification and denitrification, removal of heavy metals and removal of organic compounds was reviewed and combined adsorbed and entrapped mixed microbial cell system was developed to evaluate the feasibility for the treatment of soluble phenol wastewater. Various entrapping carriers were tested, including calcium alginate, polyacrylamide, k-carrageenan, and cellulose triacetate. Steady-state operational performance, operational stability, and tests with other phenolic synthetic wastewaters were explored. Monocarrier (cellulose triacetate) was found to serve as the carrier for the immobilization of cells and it was better than bicarrier (mixed cellulose triacetate and calcium alginate) in terms of the capability to maintain high SRT (solid residence time), and operational performance. For phenol synthetic wastewater, the critical loading rate was 9 g COD (chemical oxygen demand)/L/day and a 5 to 7 day start up period was required. The system could take quantitative (concentration and hydraulic) shock loads of phenol synthetic wastewater very well without the aid of external sludge recycling. For 2,4-dichlorophenol synthetic wastewater, phenol-acclimated cells effectively degraded dichlorophenol at 250 and 500 mg/L. (See also W91-07454) (VerNooy-PTT)
W91-07457

MORPHOLOGY AND ELECTRON MICROSCOPY OF MICROBIAL AGGREGATES.
University of Western Ontario, London. Dept. of Chemical and Biochemical Engineering.
N. Kosaric, and R. Balszczyk.
IN: Wastewater Treatment by Immobilized Cells. CRC Press, Inc., Boca Raton, Florida. 1990. p 79-102. 8 fig, 1 tab, 123 ref.

Descriptors: *Bacterial physiology, *Biofilms, *Biological wastewater treatment, *Electron microscopy, *Microbial degradation, *Wastewater treatment, Aerobic conditions, Aggregates, Anaerobic bacteria, Biofilm reactors, Microbiological studies, Morphology, Particulate matter, Reviews.

The microbial property for aggregation is genetically inducible and may be advantageous due to interaction between adjacent organisms such as commensolism, mutualism, parasitism, and genetic exchange. The excellent performance and efficiency of the upflow anaerobic sludge blanket (UASB) reactor system for wastewater treatment is possible due to development and activity of densely packed microbial aggregates, i.e., granular sludge. Microbial aggregates may occur as a flocculent sludge, as a microbial film attached to an inert surface, and as a granule. The extracellular compounds of the aggregate link the cells resulting in its final structure which may be observed by several techniques including scanning election microscopy, X-ray microanalyzer (EDAX), transmission electron microscopy, light microscopy, and immunological probes. The two main types of aggregation of microorganisms in anaerobic conditions are immobilization on inert materials and granulation (autoimmobilization). In aerobic conditions, the immobilization of microorganisms on rotating contactors in wastewater treatment has been observed. The two layers of the biofilm consisted of an outer layer of dense filamentous Beggiatoa bacteria and an inner bacterial layer of straight and comma-shaped rods. (See also W91-07454) (VerNooy-PTT)
W91-07458

APPLICATION OF BIOMASS CARRIERS IN ACTIVATED SLUDGE PROCESS.
Toronto Univ. (Ontario). Dept. of Civil Engineering.
P. R. Senthilnathan, and J. J. Ganczarczyk.
IN: Wastewater Treatment by Immobilized Cells. CRC Press, Inc., Boca Raton, Florida. 1990. p 103-141. 17 fig, 3 tab, 150 ref.

Descriptors: *Activated sludge process, *Biofilms, *Biological wastewater treatment, *Immobilized cells, *Wastewater treatment, Adsorption, Aggradation, Biomass, Clarifiers, Microbiological studies, Polymers, Porous media, Reviews.

The performance of biological wastewater treatment systems can be improved by maintaining a high biomass concentration. The major obstacle in this endeavor has been the biomass separation in the secondary clarifiers. The biomass concentration in the biological reactors can be increased by various means of immobilization. Passive immobilization can be achieved by providing solid surfaces in aeration tanks to facilitate the natural process of microbial attachment. This application of biomass carriers to the activated sludge process combines the advantages of fixed film systems and suspended growth systems. In these hybrid systems, in addition to the biomass attached to the carriers, biological flocs free of carriers may also exist. By means of biomass carriers it is possible to obtain a two to fivefold increase in biomass concentration in the aeration tanks compared to that in the conventional activated sludge process. The increased concentration of immobilized biomass could reduce process dependence of secondary clarification and lead to reduced volume of the reactor, increased treatment system stability, and its improved performance. Efficiency can be further enhanced by selecting biomass carriers which possess adsorption capacity for substrates and metabolic end products. These carriers may be stationary or mobile depending upon their size. Macrocarriers such as modular plastic and synthetic fiber media are fixed in the aeration basin, and porous polyurethane media are suspended. These macrocarriers can easily be retained in the system without the necessity of the secondary clarifiers; however, they occupy a large volume in the reactor. Microcarriers (less than 1000 micrometers in size) are suspended in the aeration tanks and provide a large surface area for the immobilization of biomass without reducing the effective volume of the tanks. These carriers are easy to handle; however, due to their size, additional measures of separation and recycling are needed to retain them in the aeration basins. (See also W91-07454) (Author's abstract)
W91-07459

EFFLUENT TREATMENT WITH IMMOBILIZED MICROALGAE AND CYANOBACTERIA: A CRITICAL ASSESSMENT.
Laval Univ., Quebec. Faculty of Food Sciences and Agriculture.
J. de la Noue, P. Chevalier, and D. Proulx.
IN: Wastewater Treatment by Immobilized Cells. CRC Press, Inc., Boca Raton, Florida. 1990. p 143-152. 59 ref.

Descriptors: *Algae, *Biofilms, *Biological wastewater treatment, *Cyanobacteria, *Immobilized cells, *Tertiary wastewater treatment, *Wastewater treatment, Adsorption, Advanced wastewater treatment, Chlorophyta, Microbiological studies, Nutrient removal, Reviews.

The of using microalgae for wastewater treatment is to provide a tertiary treatment for urban or agricultural effluents. The microalgae efficiently take up nutrients such as nitrogen (ammonium or inorganic oxidized forms) and phosphorus (orthophosphate) that cause eutrophication problems when discharged into natural bodies of water. Even though the immobilization of microalgae and cyanobacteria is far from being as developed as that of bacteria or yeasts, systems have been studied for various purposes, including wastewater treatment. Various classical materials or matrices have been used for algal cell entrapment or fixation and various shapes of carriers have been tried: beads, cubes, or pellets, filamentous layers, and discs for entrapment. Criteria for a successful immobilization system include: stability, light penetration, viability and physiological state, and participation of the support material in the nutrient depletion from the medium. Both Chlorophyta and cyanobacteris have been studied for use in wastewater treatment although Chlorophyta have been studied more extensively. Results using Scenedesmus obliquus indicate that growth rates are similar to that of free algae, although the initial lag period appears to be a little longer on secondary urban effluents. There is some indication that cyanobacteria may have an advantage due to the filamentous nature of some that makes harvesting easier. Although the immobilization of microalgae and cyanobacteria is not yet extensively developed, indications are that they may be useful in wastewater treatment. (See also W91-07454) (VerNooy-PTT)
W91-07460

IMMOBILIZED CELL SYSTEMS IN ANAEROBIC DIGESTION PROCESSES.
Biotechnology Research Inst., Montreal (Quebec). Environmental Engineering Group.
R. Samson, A. Pauss, and S. R. Guiot.
IN: Wastewater Treatment by Immobilized Cells. CRC Press, Inc., Boca Raton, Florida. 1990. p 153-190. 8 fig, 3 tab, 115 ref.

Descriptors: *Anaerobic digestion, *Biofilm reactors, *Biofilms, *Biological wastewater treatment, *Immobilized cells, *Wastewater reactors, *Wastewater treatment, Adsorption, Aggregates, Bacterial physiology, Biomass, Design criteria, Hydrodynamics, Microbial degradation, Reviews.

Technologies using immobilized cell anaerobic reactors such as the fixed-film, expanded bed, and fluidized bed reactors and the well-known upflow sludge bed system with its variants were evaluated. The sludge bed reactor takes advantage of the natural self-aggregation ability of microorganisms, while the processes in fixed-film, expanded, and fluidized bed reactors utilize the ability of microorganisms to attach and colonize a solid material. The factors involved in the formation and maintenance of fixed films and granular sludge include quality of the inoculum, composition of substrate, ionic properties of the medium, and hydrodynamic selection pressure. Design and operational problems associated with the use of large-scale anaerobic immobilized cell reactors include the effect of the geometry of anaerobic reactors on hydrodynamic performance and the effect of hydrodynamics on reactor start-up and steady-state performance. Development of biofilm or granules is in essence a purely biological process since it is dependent on the sludge seed, the substrate composition, the physiology of the bacteria, and the hydrodynamic selection pressure. At the ecological level, cell-cell interactions promote aggregation of the bacteria. The different members of a methanogenic consortium adhere to each other to form a highly organized microbial community where the substrate transfer is greatly facilitated. Close contact due to adhesion also enhances the energy pool to the benefit of different members of the association. Day-to day operation of modern anaerobic reactors poses the problem of proper mixing of the reactor contents. Mixing studies using tracers is the most effective way to ensure a good design of anaerobic reactors and allows the operator to monitor, on a regular basis, the real organic loading rate applied to the biomass. (See also W91-07454) (VerNooy-PTT)
W91-07461

BIOLOGICAL PROCESSES IN TOXIC WASTE TREATMENT.
Windsor Univ. (Ontario). Dept. of Civil and Environmental Engineering.
J. K. Bewtra, and N. Biswas.
IN: Wastewater Treatment by Immobilized Cells. CRC Press, Inc., Boca Raton, Florida. 1990. p 191-222. 5 fig, 11 tab, 48 ref.

Descriptors: *Biofilms, *Biological oxidation, *Biological wastewater treatment, *Microbiological studies, *Toxic wastes, *Wastewater reactors, *Wastewater treatment, Bacterial physiology, Biodegradation, Growth kinetics, Immobilized cells, Microorganisms, Model studies, Reviews, Toxicity.

The basic concepts of toxicity, relevant models available to describe toxic effects, and biological processes in the treatment of municipal and industrial wastewaters in the presence of toxic substances were examined. Many substances exert a toxic effect on biological oxidation processes and partial or complete inhibition may occur depending on their nature and concentration. Toxicity to microorganisms may result due to excess concentrations of substrate itself, the presence of inhibiting substances or factors in the environment, and/or the production of toxic by-products. Many wastewater constituents are toxic to microorganisms. These toxic substances can be divided into the following categories: trace organics, heavy metals, light metals, acids and bases, and other organic and inorganic substances. Available information strongly indicates that immobilized biological systems are less sensitive to toxicity and have a higher efficiency in degrading toxic and hazardous materials. In biological wastewater treatment processes where a toxic substance is present, the Haldane equation, instead of the Michelis-Menten or Monod equation is generally used to model substrate degradation and microbial growth. The toxicity of a substance to the wastewater treatment process can be divided into three major categories: microorganisms involved in the process, system kinetics, and reactor engineering. The biochemical, genetic, and ecological ability of the microorganisms in the biomass play an important role in metabolizing the organic toxicants in the wastewater. A simple comparison of influent and effluent concentrations in the wastewater stream to measure process performance may provide a false indication of biodegradation of the pollution under consideration. Therefore, it is imperative to develop a different method for determining the removal efficiency of a toxic pollutant in a biological process. One of the promising approaches in biodegradation of toxic organics is the development of genetically engineered microorganisms. However, before genetically engineered microorganisms are developed and used for improved treatment of toxic wastes, their broader implications to the environment should be fully researched and understood. (See also W91-07454) (VerNooy-PTT)
W91-07462

FUNDAMENTALS AND ADVANCES IN EXPANDED BED REACTORS FOR WASTEWATER TREATMENT.
New York State Coll. of Agriculture and Life Sciences, Ithaca. Dept. of Agricultural and Biological Engineering.
W. J. Jewell.
IN: Wastewater Treatment by Immobilized Cells. CRC Press, Inc., Boca Raton, Florida. 1990. p 223-252. 18 fig, 1 tab, 27 ref.

Descriptors: *Biofilm reactors, *Biofilms, *Biological wastewater treatment, *Immobilized cells, *Wastewater treatment, Biomass, Design criteria, Microorganisms, Particle size, Wastewater reactors.

Microorganisms in an attached film have been used for more than a century for wastewater treatment. The expanded bed process uses a fine particle upflow filter in which the particles are slightly expanded but remain in close proximity to other particles. Design requirements of the expanded bed include particle size and surface area; particle size, reactor liquid velocity, and hydraulic retention times; head loss considerations; expanded bed dimensions; particle size and 'active microbial mass'; and particle size, biofilm depth, biofilm density, and maximum reactor concentrations. A comparison is made of the actual concentration of biomass that would occur in a reactor for varying size particles and different film depths for an expanded bed and fluidized bed. Past reports on wastewater treatment with the expanded bed are summarized. These include studies on temperature and substrate effects, suspended solid and microbial film interactions, solids retention time requirements, and film density and thickness relationships. Future wastewater treatment possibilities discussed are high rate anaerobic conversion, low-temperature applications, and hazardous waste treatment applications. Although the anaerobic process offers much to the wastewater treatment field, there are obvious limitations including minimum effluent concentration, sulfur cycle complications, nutrients, and attached film reactor 'bulking'. (See also W91-07454) (VerNooy-PTT)
W91-07463

FLUIDIZED BED REACTOR IN WASTEWATER TREATMENT.
Little (Arthur D.), Inc., Cambridge, MA. Biochemical and Pharmaceutical Technology Unit.
K. Vembu, and R. D. Tyagi.
IN: Wastewater Treatment by Immobilized Cells. CRC Press, Inc., Boca Raton, Florida. 1990. p 253-265. 5 tab, 39 ref.

Descriptors: *Biofilm reactors, *Biofilms, *Biological wastewater treatment, *Fluidized bed process, *Wastewater treatment, Biomass, Design criteria, Hydraulic loading, Load distribution, Microbial degradation, Particulate matter.

The application of fixed film biological reactors, fluidized bed systems in particular, for the treatment of wastewater is on the increase. A typical fluidized bed process involves pumping wastewater up through a bed of solid support at the fluidization velocity, that is, at a velocity where the support particles are no longer in permanent contact with each other. The fluidized bed has significant advantages over other processes, and key process design parameters include biomass production, nutrient requirements, volumetric loading rate, recycle ratio, and hydraulic loading rate. Potential technical issues and problems include: (1) design of a proper distribution system to achieve uniform fluidization; (2) lack of effective dissolved oxygen; (3) high energy requirements; (4) high shear due to hydraulic loading; and (5) loss of support particles. Factors that should be considered in selection of support particles are adsorption of dissolved organics, transport of biomass to the solid surface and the adhesion of the biomass, microbial production of extracellular polymers, and biofilm formation due to cellular reproduction. A list of currently known applications, including carbonaceous BOD removal by aerobic and anaerobic processes and ammonia nitrogen removal by nitrification and denitrification, are presented. Feasibility studies involving new applications, especially on hazardous wastes, are essential to establish the potential of fluidized bed reactors. (See also W91-07454) (VerNooy-PTT)
W91-07464

DETERMINATION OF ADAPTATION OF THE ACTIVATED SLUDGE FOR INDUSTRIAL WASTEWATER.
Kemijski Inst. Boris Kidric, Ljubljana (Yugoslavia).
M. Ros, and M. Dular.
Zeitschrift fuer Wasser- und Abwasser-Forschung ZWABAQ, Vol. 23, No. 5, p 189-192, October 1990 3 fig, 7 tab, 11 ref.

Descriptors: *Activated sludge, *Adaptation, *Analytical methods, *Industrial wastewater, *Respirometry, *Wastewater analysis, *Wastewater treatment, Chemical wastewater, Dissolved oxygen, Domestic wastes, Oxygen demand, Oxygen requirements, Pharmaceutical wastes.

In order to study the adaptation of activated sludge, three different types of industrial wastewaters (chemical and pharmaceutical wastewaters and wastewater from the manufacture of semisynthetic antibiotics) were chosen and mixed with sanitary and domestic wastewater. Chemical and 5-day biochemical oxygen demand (BOD) removal, dissolved oxygen, BOD determined by means of respirometry, and endogenous oxygen consumption rate were measured. The respirometric BOD determination was used to measure adaptation. It was found that the duration of adaptation was from 10 days for wastewater from the chemical and pharmaceutical industries to 22 days for wastewater from the production of antibiotics. It was also ascertained that this respirometric technique was the most suitable method for the determination of adaptation by activated sludge. The technique is suitable for studying the adaptation of new kinds of wastewater for new treatment plants and the introduction of new types of wastewater into existing wastewater treatment plants. (King-PTT)
W91-07544

CONSTRUCTED WETLANDS FOR WASTEWATER TREATMENT.
Environmental Protection Agency, Cincinnati, OH. Risk Reduction Engineering Lab.
S. C. Reed.
Biocycle BCYCDK, Vol. 32, No. 1, p 44-49, January 1991. 6 tab.

Descriptors: *Artificial wetland treatment, *Artificial wetlands, *Construction costs, *Construction methods, *Wastewater treatment, *Wetlands treatment, Design criteria, Emergent aquatic plants, Flow path, Free water surface, Soil saturation, Wetlands.

Wetlands are defined as vegetated land where the water surface is near the ground surface long enough each year to maintain saturated soil conditions. Constructed wetlands are those systems specifically designed for wastewater treatment and located at a site where natural wetlands did not exist, at least at the time of construction. There are two different types of constructed wetlands, characterized by the flow path of the water in the system: (1) free water surface (FWS) wetlands which contain appropriate emergent aquatic vegetation in a relatively shallow bed or channel and where the surface of the water is exposed to the atmosphere as it flows through the bed, and (2) subsurface flow (SF) wetlands which contain a foot or more of permeable medium (rock, gravel, sand, and soil have all been used); this medium supports the root system of the same types of emergent vegetation, but in this case, the water level in the bed is maintained below the top of the medium in an attempt to keep all wastewater flow beneath the surface. Fifty-six FWS and 98 SF-type wetlands have been constructed to date in the United States. There is as yet no generally-accepted consensus regarding the design of these systems. SF wetlands average 1.8 acres in area and have an average flow of 0.3 million gallons per day, while FWS wetlands average 88.5 acres and have a mean flow of 1.8 mgd. The FWS wetlands have been built at an average cost of $22,200 an acre, whereas the average cost per acre for SF wetlands has been $87,200. (Medina-PTT)
W91-07558

MEASURING COMPOST SUBSTRATE DEGRADABILITY.
Los Angeles City Solids Technology Div., CA.
R. T. Haug, and W. F. Ellsworth.
Biocycle BCYCDK, Vol. 32, No. 1, p 56-61, January 1991. 3 fig, 4 ref.

Descriptors: *Analytical methods, *Composting, *Degradation, *Respirometry, *Substrates, *Waste treatment, Cost analysis, Energy, Laboratory equipment, Laboratory methods, Mass, Measuring instruments.

Knowledge of the mass and energy balance is essential to the proper design and operation of all composting systems, and a key step is determining substrate degradability. Because substrate degradability can vary widely, and because the energy balance is so important to the process, actual de-

gradability should be determined whenever possible. A constant pressure respirometer was assembled from generally available laboratory supplies to measure substrate degradability with large size samples. Experience with the apparatus demonstrated that it can provide useful data at relatively low capital cost. Procedures to avoid rate limitations were refined. It is believed that development of standardized procedures and equipment should make measurement of substrate degradability a more common practice for composting facilities. (Medina-PTT)
W91-07559

ANALYTICAL SOLUTION FOR DENSITY CURRENTS IN SETTLING BASINS.
Universidade Federal do Parana, Curitiba (Brazil).
For primary bibliographic entry see Field 8B.
W91-07591

EVALUATING THE COSTS OF PACKED-TOWER AERATION AND GAC FOR CONTROLLING SELECTED ORGANICS.
Environmental Protection Agency, Cincinnati, OH. Drinking Water Research Div.
J. Q. Adams, and R. M. Clark.
Journal of the American Works Association, JAWWA5, Vol. 81, No. 1, p 49-57, January, 1991. 8 fig, 5 tab, 14 ref.

Descriptors: *Air stripping, *Cost-benefit analysis, *Granular activated carbon, *Organic pollutants, *Packed-tower aeration, *Water quality control, *Water treatment, Emission control, Henrys Law, Pesticides, Safe Drinking Water Act, Synthetic organic compounds.

The 1986 amendments to the Safe Drinking Water Act identify granular activated carbon (GAC) and packed-tower aeration (PTA) as feasible treatment techniques for synthetic organic chemicals. A preliminary cost analysis was performed to compare liquid-phase GAC treatment with PTA treatment, with and without air emissions control. Unit costs for PTA treatment with and without air emissions control are shown to follow a fairly consistent decreasing trend with increasing Henry's coefficient. This provides a preliminary means of estimating costs given the Henry's coefficient and system size. In general, the cost of PTA treatment approximately doubles when off-gas control using vapor-phase GAC is included in the system. Cost-effective design of a liquid-phase GAC system depends greatly on selection of adsorber type and configuration, empty-bed contact time (EBCT), GAC usage rate, and method of spent carbon reactivation or replacement. Steel pressure post-filter adsorbers appear to be cost-effective for small systems, and concrete gravity contactors are economical for large systems. EBCTs of 10-20 min provide cost-efficient designs for most organics examined. On-site reactivation appears to be economical when spent carbon requirements are >2000 lb/d. For smaller quantities, replacement with virgin GAC or off-site reactivation may be most economical. For most of the contaminants examined, PTA treatment appears to be more cost-effective than liquid-phase GAC treatment, even when vapor-phase GAC is required in the stripping system. Exceptions are the pesticides dibromochloropropane (DBCP) and ethylenedibromide (EDB), for which liquid-phase GAC appears to be more appropriate. (Fish-PTT)
W91-07605

SURVIVAL AND CATABOLIC ACTIVITY OF NATURAL AND GENETICALLY ENGINEERED BACTERIA IN A LABORATORY-SCALE ACTIVATED-SLUDGE UNIT.
University Coll., Cardiff (Wales). School of Pure and Applied Biology.
N. C. McClure, J. C. Fry, and A. J. Weightman.
Applied and Environmental Microbiology AEMIDF, Vol. 57, No. 1, p 366-373, February 1991, 5 fig, 2 tab, 49 ref.

Descriptors: *Activated sludge, *Biodegradation, *Genetic engineering, *Pseudomonas, *Wastewater treatment, Chlorinated hydrocarbons, Dechlorination, In situ treatment, Plasmids.

The survival of selected naturally occurring and genetically engineered bacteria in a fully functional laboratory-scale activated-sludge unit (ASU) was investigated, in order to assess the in vivo activity of recombinant strains in wastewater treatment systems. The effect of the presence of 3-chlorobenzoate (3CB) on the survival of Pseudomonas putida UWC1, with or without a chimeric plasmid, pD10, which encodes 3CB catabolism, was determined. P. putida UWC1(pD10) did not enhance 3CB breakdown in the ASU, even following inoculation at a high concentration (300 million CFU/ml). The emergence of a natural, 3CB degrading population appeared to have a detrimental effect on the survival of strain UWC1 in the ASU as indicated by a rapid decline in the introduced strains concurrent with the rise of the natural strains. The fate of these emergent 3CB-utilizing bacteria, derived from activated-sludge microflora, was studied in experiments in which these strains were inoculated into the ASU. Both strains, AS2, an unmanipulated natural isolate which flocculated readily in liquid media, and P. putida ASR2.8, a transconjugant containing recombinant plasmid pD10, survived for long periods in the ASU and enhanced 3CB breakdown at 15 C. If the use of artificially introduced microbial inoculants for the breakdown of target pollutants in natural habitats is to be successful, such environmental factors as predation, competition, resistance to starvation, motility, nutrient concentration, presence of growth inhibitors, and physical factors such as oxygen concentrations, temperature and pH must be considered. (Doyle-PTT)
W91-07648

BIODEGRADATION OF MORPHOLINE IN RIVER WATER AND ACTIVATED SLUDGE.
Leeds Univ. (England). Dept. of Microbiology.
For primary bibliographic entry see Field 5B.
W91-07659

HAZARDOUS AND INDUSTRIAL WASTES: PROCEEDINGS OF THE 22ND MID-ATLANTIC INDUSTRIAL WASTE CONFERENCE.
Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. 793p. Edited by Joseph P. Martin, Shi-Chieh Cheng and Mary Ann Susavidge.

Descriptors: *Conferences, *Environmental protection, *Hazardous wastes, *Industrial wastes, *Waste treatment, *Wastewater treatment, Incineration, Regulations, Rehabilitation, Resource Conservation and Recovery Act, Resources management, Risk assessment, Site remediation, Sludge treatment, Superfund, Toxic wastes, Waste management, Waste recovery, Water analysis, Water reuse.

The Mid-Atlantic Industrial Waste conference is an annual gathering of consultants, industrial environmental managers, regulators and academicians. Ideas and information on dealing with modern industrial society production byproducts are exchanged at the conference. The program of the Twenty-Second Mid-Atlantic Industrial Waste Conference reflected acceptance and maturation of environmental regulation. The management theme focused on regulatory implementation and compliance, whereas the technical program covered process wastewater, sludge treatment and disposal, remediation, waste minimization or reuse. The conference was held July 24-27, 1990 at Drexel University, in Philadelphia, PA. Universities, governmental agencies, and several organizations sponsored the conference. Specific papers discussed regulations, innovative treatment, site assessment and technology, waste minimization and resource recovery, risk assessment, water reuse, remediation, treatment technologies, sludge treatment, land disposal, analytical procedures, toxic materials and thermal treatment. (See W91-07663 thru W91-07712) (Mertz-PTT)
W91-07662

FEASIBILITY STUDIES FOR THE REMOVAL OF HEAVY METALS FROM SOLUTION USING TAILORED BENTONITE.
New Mexico State Univ., Las Cruces. Dept. of Civil Engineering.
F. Cadena, R. Rizvi, and R. W. Peters.
IN: Hazardous and Industrial Wastes: Proceedings of the 22nd Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 77-94. 5 fig, 1 tab, 31 ref.

Descriptors: *Adsorption, *Bentonite, *Heavy metals, *Wastewater treatment, *Water pollution prevention, *Water treatment, Chromium, Clean-up, Environmental protection, Lead, Soil contamination, Waste disposal.

In recent years, increased numbers of heavy metal-contaminated soils have been reported. The metals can be assimilated by plants, accumulate in soils, disperse into publicly owned treatment works, or contaminate the groundwater. Common unit operations for removal of heavy metals from solution include chemical precipitation, ion exchange, electrochemical reduction, reverse osmosis, and activated carbon adsorption. As an alternative to these technologies, the feasibility of tailoring natural clays to improve the adsorption capacity of the clays for heavy metals was examined. Such procedures, while ineffective for removing heavy metals from the subsurface environment, would effectively retard the movement of heavy metals through the unsaturated (vadose) zone of the soil to the groundwater. The adsorption of lead and chromium onto bentonite clay which was tailored using tetramethyl ammonium ions was examined. Results indicate that the tailoring process drastically increased the removal of lead from solution by adsorption onto the bentonite clay. The addition of the tetramethyl ammonium ions as the tailoring agent greatly enhanced the adsorption capacity for chromium. The optimal tetramethyl ammonium ions:cation exchange capacity ratio was 35% for lead and 8% for chromium. The linear partition coefficient was increased by factors of 18.4 for lead and 1.4 for chromium, as compared to no tailoring agent addition. Modeling the heavy metal adsorption using the Fruendlich isotherm indicated that the adsorption of lead was favorable at low tetramethyl ammonium ions dosages, while the adsorption of chromium was nearly linear. (See also W91-07662) (Mertz-PTT)
W91-07668

UTILIZING HIGH ENERGY ELECTRONS FOR TREATMENT OF INDUSTRIAL WASTES CONTAINING NON-BIODEGRADABLE ORGANIC COMPOUNDS.
Miami Univ., Coral Gables, FL.
T. D. Waite, C. N. Kurucz, and W. J. Cooper.
IN: Hazardous and Industrial Wastes: Proceedings of the 22nd Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 95-99. 2 fig, 4 ref.

Descriptors: *Electron irradiation, *Hazardous wastes, *Industrial wastes, *Irradiation, *Waste treatment, *Wastewater treatment, Chemical reactions, Effluents, Electron accelerator, Hazardous waste disposal, Organic wastes, Toxic wastes.

Innovative technologies for the treatment of waste effluents, especially those containing hazardous wastes, are rapidly being explored. One process that has emerged is the utilization of high energy electrons for destruction of non-biodegradable organics in aqueous systems. Electron beam irradiation of wastewater effluents containing several hazardous organic compounds was examined. The electron accelerator utilized was a full scale accelerator unit treating approximately 120 gallons per minute. The electron accelerator was a 1.5 million electronvolt beam rated at 50 milliamps output, therefore, the power of this machine was 75 kilowatts. Depending on the flow present to the beam, this system was capable of continuously delivering between 0 and 850 kilorads of absorbed dose. Hazardous chemicals were injected into influent streams and were then passed through the electron beam via a weir delivery system. Results showed that electron beam irradiation of wastewater containing hazardous organics is an effective treatment mechanism. The electron beam process is essentially insensitive to effluent quality with effective removal observed in both clean water streams, as well as in raw domestic sewage. In addition, be-

cause both aqueous electrons and hydroxyl radicals are formed upon electron radiation of water, most organic compounds are destroyed readily even though only one reactive species is dominant in the reaction. It appears, therefore, that electron beam irradiation is an innovative technology that has tremendous potential for solving many organic waste problems especially those situations where toxic or hazardous organics are involved. (See also W91-07662) (Mertz-PTT)
W91-07669

ECONOMIC ANALYSIS OF WASTEWATER SYSTEM RETROFITS FOR THE METAL SURFACE FINISHER.
JACA Corp., Fort Washington, PA.
T. Daily.
IN: Hazardous and Industrial Wastes: Proceedings of the 22nd Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 129-143. 3 fig, 7 tab.

Descriptors: *Cost analysis, *Industrial wastes, *Metal-finishing wastes, *Wastewater disposal, *Wastewater treatment, Cost savings, Costs, Economic aspects, Feasibility studies, Future planning, Operating costs.

Metal finishing and coating plant managers are facing escalating costs for the disposal of wastewater generated in their production processes. This trend is expected to continue over the foreseeable future. With disposal costs increasing, retrofit technologies, treatment techniques, and equipment options that in the past have not been economical, have become more attractive as an investment opportunity for reducing overall wastewater disposal costs. Engineers faced with the task of finding ways to reduce overall plant costs can turn to the waste disposal system as a way of generating savings. Economic analysis can be used as a quantitative method to rank investment options monetarily. An economic analysis lists all increases and decreases in operating costs and production for all retrofit alternatives. Operating costs that can be impacted by segregation of a wastewater are: sludge disposal costs; increased labor for maintenance and equipment operation; decreased labor due to the requirement for less operator attention; and increased treatment chemical costs. Operating costs that can be influenced by the removal of contamination from a process bath are: decreased sludge volume; increased labor for the operation and maintenance of retrofit equipment; increased disposal costs; reduced process chemical usage from return of process chemicals and less frequent dumps; reduced operating temperatures; reduced wastewater treatment chemicals; and reduced quantities of wastewater discharges to publicly owned treatment works. Operating costs affected by waste minimization are: decreased sludge generation, increased energy usage, and increased labor costs. There are some good retrofits available to a metal surface finishing plant. For planning purposes, rough budgetary analysis can be used to determine which alternatives to study. Once an alternative starts to become economically feasible, a more detailed study is required. (See also W91-07662) (Mertz-PTT)
W91-07672

TREATMENT SYSTEM BRINGS GAS MANUFACTURER INTO COMPLIANCE.
Holston Gases, Inc., Knoxville, TN.
K. Wilson, and W. E. Griggs.
IN: Hazardous and Industrial Wastes: Proceedings of the 22nd Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 144-154. 4 fig, 4 tab.

Descriptors: *Acetylene, *Industrial wastes, *Sludge disposal, *Sludge treatment, *Tennessee, *Wastewater treatment, Filter presses, Permits, Sludge cake, Sludge drying, Wastewater treatment facilities, Water reuse.

A Knoxville, Tennessee based gas manufacturing facility faced stiff fines from the State's Division of Water Pollution Control for discharging process wastewater to the Tennessee River. The discharge was generated from the production of acetylene gas. The resulting wastewater consisted of a lime slurry referred to as carbide lime. A study was authorized to determine the actions necessary to obtain a National Pollutant Discharge Elimination System Permit or the pretreatment requirements necessary for discharge into the municipal sewer. It was decided to eliminate a surface discharge and to thicken the resulting sludge to facilitate its disposal at the local landfill. An average of 33,090 pounds per month of calcium carbide is generated into acetylene, creating an average of 19.7 tons of sludge per month. If the settled sludge is 38% solids and weighs approximately 10 pounds per gallon, then the daily sludge production is 504 gallons per day. The design press size required was determined to be 16.9 cubic feet. A Shriver Model M800FB filter press was installed. The press can dewater unsettled lime slurry in less than an hour. The resulting cake is dry enough to be broken into pieces by hand. The treatment system produces a water of such quality as to permit it to be recycled and reused in the acetylene production process. The potential fines associated with either a National Pollutant Discharge Elimination System Permit or a pretreatment permit are eliminated along with the monitoring and reporting requirements of such permits. (See also W91-07662) (Mertz-PTT)
W91-07673

BIOLOGICAL TREATMENT OF AN EXPLOSIVES PRODUCTION WASTEWATER.
Army Biomedical Research and Development Lab., Fort Detrick, MD.
W. D. Burrows.
IN: Hazardous and Industrial Wastes: Proceedings of the 22nd Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 339-354. 7 fig, 4 tab, 12 ref.

Descriptors: *Activated sludge process, *Chemical wastewater, *Explosives, *Industrial wastewater, *Munitions wastes, *Wastewater treatment, Aerobic treatment, Clarifiers, Filters, Hazardous wastes, Organic compounds, Wastewater facilities.

In producing approximately 10,000,000 kg/month of crude RDX (hexahydro-1,3,5-trinitro-1,3,5-triazine) and HMX (octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine) explosives, the Holston Army Ammunition Plant (HSAAP) employs the Bachman process, whereby hexamethylenetetramine is nitrated with nitric acid and ammonium nitrate in the presence of acetic anhydride. In 1983, HSAAP put into operation the first advanced wastewater treatment system serving a Bachman facility. The U.S. Army Biomedical Research and Development Laboratory has undertaken an evaluation of the major unit processes of this system in order to provide guidance for selection of appropriate technologies for treating wastewaters at a projected new RDX manufacturing plant. The Holston wastewater treatment plant is a well-constructed facility of conventional design, built to accommodate half the average wastewater flow of 0.56 cubic m/second projected for full mobilization and now receiving an average of 0.22 cubic m/second, or 80% of capacity, at 15% mobilization. The activated sludge system has consistently achieved nearly complete removal of biodegradable organics using less than the available aeration capacity; and clarifiers, dual media filters, and sludge handling facilities have performed satisfactorily. Experience at the Holston provides limited guidance for construction of a treatment plant at the new RDX facility, where the wastewater is expected to be several times stronger with respect to soluble parameters. The combination of aerobic filter and aeration basins will probably reduce degradable organics in the stronger wastewater to an acceptable level; but it is recommended that a combined aerobic/anoxic alternative, such as a sequencing batch reactor or a continuous oxidation ditch, be given serious consideration. (See also W91-07662) (Mertz-PTT)
W91-07685

TOXICITY REDUCTION THROUGH AN AERATED SUBMERGED BIOLOGICAL FILTER TREATING WASTEWATER FROM AN OIL REFINERY SOUR WATER STRIPPING UNIT.
Oklahoma State Univ., Stillwater. School of Civil Engineering.
C. G. Carroll, J. N. Veenstra, and S. L. Burks.
IN: Hazardous and Industrial Wastes: Proceedings of the 22nd Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 355-376. 11 fig, 8 tab, 12 ref.

Descriptors: *Biological wastewater treatment, *Hazardous wastes, *Industrial wastes, *Oil refineries, *Toxic wastes, *Wastewater treatment, Aeration, Biological filters, Organic compounds, Sour water, Toxicity, Waste treatment.

Attempts were made to reduce the toxicity, as determined by acute biological assays, of wastewater coming from a sour water stripping unit at an oil refinery. The oil refining industry seldom had trouble meeting traditional standards, but has great difficulty meeting the new toxicity standards. When refineries crack hydrocarbons, steam is used to strip out the ammonia, phenols, and hydrogen sulfides produced by the process. The steam is then condensed and becomes sour water which contains high concentrations of the compounds as well as a large quantity of other organic compounds. Research indicates a major portion of the toxicity in this waste stream may be attributed to the base neutral, methylene chloride extractable, nonpolar organic fraction. Background information was examined concerning the composition of the sour water waste stream, its toxicity, and preliminary treatability data. The efficiency of an aerated submerged biological filter was examined as a means of reducing toxicity in the sour water stripper waste stream. The aerated submerged biological filter unit incorporates features of both fixed-film and completely-mixed activated sludge units. The aerated submerged biological filter unit was definitely reducing the toxicity of the waste stream in almost all cases. Because wastewaters coming directly off of a process unit were treated in this experiment, the absence of huge decreases in toxicity should not necessarily be taken as a sign of poor reactor performance. The aerated submerged biological filter has definite potential in terms of both economics and treatment efficiency due to its compact size, ease of operation relative to other biological systems, its demonstrated ability to remove toxicity from a waste stream, and the option to run the units is series or parallel depending on waste strength. (See also W91-07662) (Mertz-PTT)
W91-07686

TREATABILITY OF A FRENCH INDUSTRIAL LANDFILL LEACHATE USING A BIOLOGICAL TRICKLING FILTER.
Institut National des Sciences Appliquees de Lyon, Villeurbanne (France). Lab. de Chimie et Genie de l'Environnement.
P. Eyraud, C. Comel, and J. Veron.
IN: Hazardous and Industrial Wastes: Proceedings of the 22nd Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 377-397. 6 fig, 2 tab, 25 ref.

Descriptors: *Biological filters, *Landfills, *Leachates, *Trickling filters, *Wastewater treatment, *Water pollution prevention, Aerobic treatment, Flow rates, France, Industrial wastes, Pilot plants, Waste load.

A the center of concerns about landfill management is an awareness of the potential problems caused to the environment by leachates from landfills. In France, as in the U.S., such concerns have led to increased technical study of approaches to leachate treatment. Biological treatment of landfill leachate using a trickling filter was investigated. The Mennevill landfill is located in the northeast of France where the meteorological conditions are often rainy and during the winter period the temperatures are low. The rainy conditions lead to a large amount of leachate. The pilot scale apparatus was a two-stage aerobic biological trickling filter. The reactors were both composed of a cylinder of 1 m external diameter and 2.25 m height that could easily contain 2 cubic m of support and the wastewater sprinkling system and a cylindrical conical settling tank. Treatment occurs with relatively high flow rates and therefore could be im-

plemented on a site that produces large volumes of leachates. The flow rate was closely related to the pilot efficiency and, if no other parameters are modified, an increase in the flow rate induces a reduction of the treatment effectiveness. These results emphasize the fact that all the parameters overlap in such a reactor, therefore, to manage the treatment correctly all the parameters must be considered in order to have an optimum efficiency. This can be accomplished by computerizing the pilot plant. (See also W91-07662) (Mertz-PTT)
W91-07687

ROTATING BIOLOGICAL CONTACTOR TREATMENT OF 2-NITROPHENOL AND 2-CHLOROPHENOL CONTAINING HAZARDOUS WASTES.
New Haven Univ., West Haven, CT. Dept. of Civil and Environmental Engineering.
R. Y. Tokuz.
IN: Hazardous and Industrial Wastes: Proceedings of the 22nd Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 398-411. 5 fig, 4 tab, 10 ref. National Science Foundation grand ECE-8512733.

Descriptors: *Activated sludge process, *Biological treatment, *Contactors, *Hazardous wastes, *Phenols, *Wastewater treatment, Biofilms, Biomass, Chemical oxygen demand, Energy use efficiency, Shock loads, Waste treatment.

Rotating Biological Contactors have a number of advantages over other biological treatment systems. They can provide high treatment efficiencies of activated sludge systems with much lower energy inputs. Organic shock loads are handled well because large biomass is present. No bulking, foaming, or floating of sludge occurs and sludge has good settleability and dewaterability. Another advantage of rotating biological contactor systems is the minimal labor requirement for operation and maintenance. Two pilot-scale rotating biological contactor units with 0.5-m diameter discs arranged in four stages were used. The discs rotated at a speed of four revolutions per minute. Total surface area of the discs was approximately 250 square feet and liquid capacity of each rotating biological contactor was about 140 L. A synthetic wastewater was used. Activated sludge taken from a local wastewater treatment plant and a water-mud mixture collected from a pond were used as seed. The biofilm was allowed to form on the discs for a period of over three months before 2-nitrophenol or 2-chlorophenol was added to the influent. Results showed that 2-nitrophenol did not affect rotating biological contactor system performance adversely, and chemical oxygen demand removal rates near 90% were obtained in the presence of about 11 mg/L of this compound. A significant amount of 2-nitrophenol could be removed in rotating biological contactors. 2-nitrophenol removal efficiencies obtained during this study were 88% or better. 2-chlorophenol did not affect the performance of the rotating biological contactor system adversely, and high (above 85%) chemical oxygen demand removal efficiencies could be obtained in the presence of approximately 3 mg/L of this compound. (See also W91-07662) (Mertz-PTT)
W91-07688

LEACHATE PRETREATMENT BY ANAEROBIC TECHNOLOGY IS COST EFFECTIVE.
Larsen Engineers, Rochester, NY.
N. Sathiyakumar, and S. R. Shrivastava.
IN: Hazardous and Industrial Wastes: Proceedings of the 22nd Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 412-421. 2 fig, 4 tab, 4 ref.

Descriptors: *Aerobic treatment, *Biological treatment, *Cost analysis, *Leachates, *Wastewater treatment, Anaerobic treatment, Dissolved oxygen, Economic aspects, Landfills, Performance evaluation, Pretreatment of wastewater, Wastewater disposal.

The typical landfill of the past was not designed with provisions for leachate collection and control. Retrofit leachate collection systems, that may be required for closure of old landfills, make necessary a safe disposal facility for collected leachate. Landfills with collection systems in place still require a safe, economical disposal alternative. Leachate can often be treated with the same processes used for industrial waste water. As the leachate is so diverse in volume, type, and concentration of contaminants, a wide variety of treatment processes may be needed to achieve the desired effluent quality. Available options to treat leachate can be broadly classified into on-site or off-site treatment systems. The two basic biological treatment processes available for treating leachate are the aerobic and anaerobic treatment processes. Aerobic treatment of leachate has several limitations. The process requires excessive electricity to maintain the necessary dissolved oxygen. Typically 4-20 times more sludge is produced compared with anaerobic treatment. More nutrients are required for aerobic treatment than anaerobic treatment. High strength waste may be difficult to handle and the process is more sensitive to environmental parameters such as temperature and loading variations than anaerobic treatment. Treatment of leachate by anaerobic process has several advantages. Reduced operation and maintenance costs mean lower sewer user fees. There is less sludge production than aerobic treatment and improved sludge dewaterability. More stable system-seasonal and intermittent operation is possible and a 90% conversion of biodegradable chemical oxygen demand to methane is possible with anaerobic treatment. The characteristics of the leachate, the number and nature of landfill sites from which the leachate is produced, the proximity of the landfill sites to a publicly owned treatment works, and the availability of receiving streams for ultimate disposal of treated leachate are a few considerations that dictate the mode by which leachate can be treated. (See also W91-07662) (Mertz-PTT)
W91-07689

DEWATERING CHARACTERISTICS OF NICKEL HYDROXIDE SLUDGES WITH PREFORMED FERRIC HYDROXIDE SLUDGE SOLIDS.
Environmental and Ecological Engineers, Inc., Pullman, WA.
S. V. Arumugam, and S. K. Bhagat.
IN: Hazardous and Industrial Wastes: Proceedings of the 22nd Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 485-500. 10 fig, 2 tab, 21 ref.

Descriptors: *Heavy metals, *Industrial wastes, *Metal sludges, *Metal-finishing wastes, *Sludge drying, *Sludge treatment, *Wastewater treatment, Filtration, Hydrogen ion concentration, Iron, Nickel, Particle size, Turbidity.

Many factors are known to influence the dewatering characteristics of metal sludges, including feed solids concentration, mixing time, mixing intensity, chemical conditioning, filtration area, filtrate viscosity, final pH of the system, particle size and distribution, particle density, and the surface properties. The effect of variables such as feed solids concentration of nickel hydroxide sludge, preformed ferric hydroxide sludge solids (conditioning aid), and the final pH of the sludge mixture appear to affect significantly the filterability of nickel hydroxide sludge. Stock suspensions of nickel hydroxide and ferric hydroxide were generated using a jar test apparatus by precipitating the corresponding salt with sodium hydroxide and by settling for 24 hours. Dissolved solids were maintained at approximately constant value for stock sludge suspensions. Test suspensions were prepared by appropriate dilution according to the requirements for experimental design. Preformed ferric hydroxide sludge solids enhanced the dewatering rate and improved the filtrate turbidity markedly. Other factors such as pH and feed solids concentration influence filtration characteristics, especially, an increase in feed solids concentration definitely improves the dewatering rate. An increase in pH of the influent solids concentration above the optimum value severely affects the dewatering characteristics investigated in this work. Results obtained demonstrate the benefits of recycling preformed ferric hydroxide sludge for dewatering of metal sludges to apply in the field. (See also W91-07662) (Mertz-PTT)
W91-07695

NIAGARA FALLS EVALUATES UNIQUE APPROACH TO REDUCING HIGH SLUDGE DISPOSAL COSTS.
For primary bibliographic entry see Field 5E.
W91-07697

TESTING FOR MICROBIOLOGICAL INHIBITION IN WASTEWATERS.
Westinghouse Environmental and Geotechnical Services, Inc., Ambler, PA.
R. E. Lees.
IN: Hazardous and Industrial Wastes: Proceedings of the 22nd Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 645-654. 3 fig, 5 tab, 9 ref.

Descriptors: *Activated sludge process, *Biological wastewater treatment, *Inhibition, *Wastewater analysis, *Wastewater treatment, Biological oxygen demand, Hydrogen ion concentration, Industrial wastes, Landfills, Microorganisms, Pulp wastes.

The Microbiological Inhibition Testing Procedure is a simple and effective screening tool for assessing inhibition of wastewaters on aerobic biological treatment systems. This batch inhibition test procedure was conducted on an industrial landfill leachate waste stream and a pulp and paper mill waste stream. If the wastewater being tested for inhibition is being evaluated for treatment at the local publicly owned treatment works, then the municipal microbial culture from that local treatment plant should be used as the biological culture in the test. For the toxicity test involving the landfill leachate studied, activated sludge mixed liquor from the local publicly owned treatment works was used. Mixed liquor from the on-site aerated lagoon was used for the pulp and paper toxicity test. Approximately three gallons of wastewater specimen is required to conduct the test. The pH of the wastewater should be measured, and if outside the range of 6.5-7.5, it should be adjusted. A range of wastewater specimen volumes is added to biological oxygen demand bottles. The biological oxygen demand bottles are incubated at 20 C for three days, at which time the final dissolved oxygen measurement is recorded on the bottles. The residual dissolved oxygen is plotted on semi-log paper against the percent volume of the wastewater specimen. Use of the inhibition testing procedure on the industrial landfill leachate waste stream demonstrated that the waste stream exhibited no inhibitory characteristics. In contrast, the use of the same procedure demonstrated that the waste stream from a pulp and paper mill showed slight inhibitory characteristics at dilutions greater than 30%. (See also W91-07662) (Mertz-PTT)
W91-07705

SUSPENDED SOLIDS EVALUATION OF A HIGHLY SALINE ORGANIC INDUSTRIAL WASTE.
Mississippi State Univ., Mississippi State. Dept. of Civil Engineering.
D. D. Truax, H. S. Sartain, and J. H. Davidson.
IN: Hazardous and Industrial Wastes: Proceedings of the 22nd Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 655-668. 7 fig, 2 tab, 5 ref.

Descriptors: *Chemical industry, *Industrial wastes, *Organic wastes, *Suspended solids, *Wastewater analysis, Industrial wastewater, Laboratory methods, Nitrogen compounds, Regulations, Wastewater disposal, Water quality standards.

A research project was conducted for a private chemical company in its effort to better characterize and control wastewater discharges. This industry is a major producer of nitrobenzene, nitrotoluene, aromatic amines and certain organic specialty chemicals. Among new permit limits were restrictions on total suspended solids. In the past, total suspended solids determination for the plant effluent was conducted by the industry and several

private laboratories. Some analyses showed variations in the concentrations from 50 to 100% for the same sample. Because of this analytical problem, and the stricter permit requirements, the industry undertook a program to improve its measurement of total suspended solids. Two approaches were explored. The first was to evaluate the different procedural variables which are involved in performing total suspended solids in accordance with standard laboratory procedures. The impact of variations in drying times, vacuum pressure and wash volumes were specifically examined. The second was to investigate the use of a nephelometric measurement for solids. Based on the results of this work, three important criteria were defined for obtaining accurate total suspended solids measurements. First, a wash volume of 100 ml needs to be used to optimize the dissolved solids wash down to the filtrate. Secondly, a drying time of at least two hours should be used before pads are removed, cooled and weighed. After this duration, pads meet the uniform weight criterion. Finally, an optimum vacuum pressure of 10-15 inches of mercury was determined. This allowed proper drawdown of dissolved solids. If these guidelines are followed, accurate results should be attainable. Results also showed that nephelometric measurement of turbidity is an inappropriate measure of suspended solids if activated carbon particulate might be present in the sample. (See also W91-07662) (Mertz-PTT)
W91-07706

SELECTION OF AIR FLOW RATES AND CULTURES IN AEROBIC BIOTOWERS FOR REMOVAL OF HYDROCARBONS FROM WASTEWATERS.
Pittsburgh Univ., PA. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5G.
W91-07707

ROTARY KILN INCINERATION SYSTEMS: OPERATING TECHNIQUES FOR IMPROVED PERFORMANCE.
Four Nines, Inc., Plymouth Meeting, PA.
For primary bibliographic entry see Field 5E.
W91-07711

RECYCLING OF INSULATION FIBERGLASS WASTE WITH A NEW VITRIFICATION PROCESS.
Vortec Corp., Collegeville, PA.
J. G. Hnat, W. F. Olix, L. M. Bartone, W. F. Talley, and A. Magley.
IN: Hazardous and Industrial Wastes: Proceedings of the 22nd Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 759-774. 3 fig, 2 tab, 2 ref. DOE Contract DE-AC01-89ER80817.

Descriptors: *Fiberglass, *Melting, *Recycling, *Vitrification, *Waste recovery, *Waste utilization, Feasibility studies, Incineration, Pilot plants, Waste disposal, Waste treatment, Waste treatment facilities.

The research and development activities completed under the first phase of a Small Business Innovation Research program for the development of an Innovative Coal-Fired Vitrification Technology for Waste Fiberglass Recycling were to determine if glass cullet or frit of satisfactory quality for recycling back to a fiberglass manufacturing facility can be produced from waste/scrap fiberglass by incineration and melting in a Vortec Cyclone Melting System using coal as the primary fuel. The following activities were performed under the first phase of the project: (1) size reduction and preparation of waste/scrap fiberglass material obtained from a fiberglass manufacturer, (2) incineration and melting testing of the waste fiberglass material in a pilot scale Vortec Cyclone Melting System, (3) chemical analysis of the cullet-frit produced and the measurement and analysis of flue gas emissions from the process, and (4) a preliminary economic evaluation of alternatives for integrating a coal-fired waste incineration/melting system into glass manufacturing facilities with conventional furnaces. The results of the program were reviewed with a major fiberglass manufacturer to assess the technical and economic feasibility of the process. Based on the successful results obtained during the feasibility phase of the program, a second follow-on effort has been initiated and is currently in progress. The second phase of the program will focus on improvement and optimization of the process via testing with a commercial scale pilot plant. The use of coal as a fuel in the recycling of fiberglass waste products can provide the glass industry with an abundant and inexpensive source of fuel, and the multi-fuel capable Vortec Cyclone Melting System provides the glass manufacturer with several options with regard to future fuel utilization. (See also W91-07662) (Author's abstract)
W91-07712

RATE OF BIODEGRADATION.
For primary bibliographic entry see Field 5B.
W91-07776

METHODOLOGY FOR DEVELOPING BEST DEMONSTRATED AVAILABLE TECHNOLOGY (BDAT) TREATMENT STANDARDS.
Environmental Protection Agency, Washington, DC. Office of Solid Waste.
For primary bibliographic entry see Field 5G.
W91-07808

FINAL BEST DEMONSTRATED AVAILABLE TECHNOLOGY (BDAT) BACKGROUND DOCUMENT FOR WASTES FROM THE PRODUCTION OF 1,1,1-TRICHLOROETHANE: K028, K029, K095, AND K096.
Environmental Protection Agency, Washington, DC. Office of Solid Waste.
For primary bibliographic entry see Field 5G.
W91-07809

EFFECT OF TEMPERATURE AND PH ON THE SETTLING BEHAVIOR OF A FLOCCULENT STRAIN OF ZYMOMONAS MOBILIS.
Universidade Federal de Pernambuco, Recife (Brazil). Dept. de Antibioticos.
C. E. Lopes, G. M. T. Calazans, E. M. M. M. Rios, and T. F. Carlos.
Biotechnology Letters BILED3, Vol. 13, No. 1, p 43-46, January 1991. 3 fig, 6 ref.

Descriptors: *Bacteria, *Flocculation, *Settling velocity, *Wastewater treatment, *Water treatment, *Zymomonas, Culturing techniques, Growth media, Hydrogen ion concentration, Temperature, Yeasts.

The batch settling technique was used to study the effect of temperature and pH on the settling behavior of a flocculant strain of the bacterium Zymomonas Z1-81. The batch settling curve remained stable in the temperatures range of 30 C to 40 C. The sedimentation rate was enhanced by increasing the temperature above this range; the reason for this phenomenon is unclear. It was found that pH plays a less significant role than temperature on the batch settling curve. Sedimentation behavior was unaffected by pH variation in the range from 5.0 to 3.0. An effect was noted when pH reached values near 1.0, although the effect was less than expected. Compared to yeast flocculation, Zymomonas mobilis flocculation displayed a significantly higher pH stability. The influence of the composition of the growth medium was significantly greater than that of temperature or pH. (Doria-PTT)
W91-07853

EFFECTS OF NICKEL, CHROMIUM AND INITIAL FEED CONCENTRATION ON THE BATCH GROWTH OF A MICROBIAL CONSORTIUM DEVELOPED FROM SEWAGE.
Middle East Technical Univ., Ankara (Turkey). Dept. of Environmental Engineering.
C. F. Gokcay, and F. B. Dilek.
Environmental Technology (Letters) ETLEDB, Vol. 12, No. 1, p 1-11, 1991. 2 fig, 12 tab, 26 ref.

Descriptors: *Activated sludge, *Chromium, *Heavy metals, *Nickel, *Wastewater treatment, Bacteria, Chemical oxygen demand, Growth, Regression analysis.

The effects of nickel, chromium, and substrate concentration on the microbial growth of acclimatized and unacclimatized microbes of sewage origin were studied in batch cultures at a constant temperature of 25 C and pH 7.0. A synthetic medium supplemented with Ni(II) (5 and 10 mg/L) or Cr(VI) (1 and 50 mg/L) or with their combinations and at various feed rate concentrations (650, 975, or 1,300 mg/L) was used. Results were analyzed by multiple regression techniques. Ni(II) was found to have a stimulatory effect on the sewage microorganisms. The effect of Cr(VI) is inhibitory; this effect is two times higher in cultures seeded with unacclimatized sewage microbes. There is a synergistic effect between Ni(II) and Cr(VI) which is more observable in the experiments with unacclimatized seeds. There is a negative interaction between Ni(II) and substrate chemical oxygen demand (COD) concentration, while the interaction between Cr(VI) and substrate COD concentration is negligible in both experiments with acclimatized and unacclimatized seeds. (Doria-PTT)
W91-07855

NOVEL METHOD FOR A PHOTOCATALYTIC DEGRADATION OF 4-NITROPHENOL IN HOMOGENEOUS AQUEOUS SOLUTION.
Warsaw Univ. (Poland). Dept. of Chemistry.
E. Lipczynska-Kochany.
Environmental Technology (Letters) ETLEDB, Vol. 12, No. 1, p 87-92, 1991. 2 fig, 1 tab, 27 ref.

Descriptors: *Industrial wastewater, *Nitrophenols, *Photocatalytic degradation, *Photolysis, *Wastewater treatment, Aromatic compounds, Decomposition, Degradation, Hydrogen peroxide, Irradiation, Priority pollutants, Ultraviolet irradiation.

4-Nitrophenol is present in industrial wastewaters from the production of dyestuffs, pesticides, and organic chemical intermediates. Degradation of 4-nitrophenol by means of hydrogen peroxide photolysis and photolysis in the presence of the Fenton reagent (FeCl2/H2O2) was investigated. Results were compared with those of the dark Fenton reaction, reported in the literature. In all cases, decomposition of the pollutant was observed. Best results were obtained when the solutions of 4-nitrophenol containing the Fenton reagent were irradiated with polychromic ultraviolet light; all of the pollutant decomposed in approximately 100 minutes, compared to 250 minutes for the dark reaction. The method can be successfully applied for the degradation of 4-nitrophenol, which is difficult to decompose by other means. More detailed investigations on the effect of electronic structure, pH, concentration, and the influence of organic salts as well as irradiation intensity on the photocatalytic degradation of 4-nitrophenol and other nitroaromatic compounds are in progress. (Doria-PTT)
W91-07859

STUDIES ON THE OXIDATIVE DECOMPOSITION OF CYANIDE ION BY POTASSIUM PERMANGANATE.
Kobe Women's Coll. of Pharmacy (Japan).
A. Adachi, S. Nojima, Y. Hagiwaras, M. Hamamoto, and T. Kobayashi.
Environmental Technology (Letters) ETLEDB, Vol. 12, No. 1, p 93-96, 1991. 4 fig, 4 ref.

Descriptors: *Cyanide, *Industrial wastewater, *Oxidation, *Potassium permanganate, *Wastewater treatment, Alkaline water, Coagulation, Decomposition, Hydrogen ion concentration, Oxidation process.

Potassium permanganate oxidation in alkaline solution was investigated for the removal of cyanide ion from wastewater. Cyanide ion in industrial wastewater was found to be almost completely decomposed after 10 minutes without the formation of such toxic compounds as cyanogen chloride. Decomposition was most efficient above pH 10. The rate of decomposition by potassium permanganate was similar to that by sodium hypochlorite. Manganese dioxide produced during the treatment process with potassium permanganate

can be removed by coagulation. (Author's abstract)
W91-07860

DEWATERING PROCESS CHANGES BOOST SLUDGE INCINERATOR EFFICIENCY.
Tutela Engineering Associates, Inc., Cranston, RI.
For primary bibliographic entry see Field 5E.
W91-07895

SLUDGE MANAGEMENT IN SAN DIEGO.
Serpentix Conveyor Corp., Westminster, CO.
For primary bibliographic entry see Field 5E.
W91-07896

CSO ABATEMENT FOR BURLINGTON, VERMONT.
O'Brien and Gere Engineers, Inc., Syracuse, NY.
For primary bibliographic entry see Field 5G.
W91-07897

PORTABLE FLOWMETER FOR SEWERS THAT SURCHARGE.
R. M. Hunter, W. A. Hunt, and A. B. Cunningham.
Water Environment & Technology WAETEJ, Vol. 3, No. 2, p 47-51, February 1991. 3 fig.

Descriptors: *Flow measurement, *Instrumentation, *Leakage, *Sewer infiltration, *Sewer systems, Design criteria, Gaging, Measuring instruments, Sewer hydraulics, Sewer surcharging, Storm water management, Theoretical analysis, Venturi flume theory, Venturi tube theory.

Deterioration of sanitary sewer systems allows excessive infiltration of groundwater and inflow of stormwater (I/I); hundreds of millions of dollars are spent annually by communities attempting to isolate and eliminate these flows. Systematic, temporary, continuous monitoring of wastewater flows in portions of municipal sewer systems isolates problems and focuses rehabilitation efforts. Various flowmeter designs are possible, including velocity-area technologies and combination Venturi flume and Venturi tube technologies. Flowmeter design and operation relies on Venturi flume theory and Venturi tube theory. A primary criterion of meter design is that the throat be constricted enough to cause critical depth. Research was conducted to ensure that the meter is capable of accurately measuring flows under conditions of free and submerged, forward and reverse, open channel flow. Hydraulic testing was conducted in two phases at two locations. Eight 25-cm and 30-cm models were tested. In all instances, smooth calibration curves relating dual bubbler differential head readings to flow rate were produced as predicted by hydraulic theory. Correction curves were developed for the case of submerged operation at tailwater depths above the modular limit of the meter, when the upstream liquid depth is increased by downstream conditions. A flowmeter design based on hydraulic theory and practical considerations was shown to produce flow-rate date consistent with that theory by independent laboratory testing. (Rochester-PTT)
W91-07898

MIXED-GROWTH SYSTEM IN USE.
Infilco Degremont, Inc., Richmond, VA.
M. K. Mierzejewski, R. F. Jaccarino, R. W. Doheney, and R. S. Heflinger.
Water Environment & Technology WAETEJ, Vol. 3, No. 2, p 57-59, February 1991. 1 fig.

Descriptors: *Biofiltration, *Biological wastewater treatment, *Tennessee, *Virginia, *Wastewater treatment, Biological oxygen demand, Boone Lake, Chemical oxygen demand, Combined sewer overflows, Performance evaluation.

The Bristol, Tennessee, and Bristol, Virginia, wastewater treatment plant (WWTP) was constructed in 1972. Wastewater flows exceeding plant capacity entered Boone Lake in 1983, resulting in possible degradation of water quality. As a result, it was recommended that the WWTP's capacity be increased, storm and sewer lines be separated, and improved sludge handling facilities be constructed. The activated biofiltration (ABF) process was chosen. ABF is a mixed-growth process that combines two standard wastewater treatment methods: activated sludge (suspended growth) and biotower or biocell (fixed growth). Four ABF cells were installed to form a rectangular structure 34.4 m long, 25.0 m long, and 6.1 m high. ABF system startup was on June 3, 1988, and all four biocells have been on-line since July 25. From October 1, 1988 to January 15, 1989, the COD removal through the biocells averaged 54%, with a 74% maximum. Significant BOD reduction occurred across the ABF cell. Process control is based on a constant food to microorganism ratio. Conversion to the ABF process allowed one of the two aeration basins to be taken out of service, and only one of the three 261-kW blowers now is used to satisfy the oxygen demand for carbonaceous oxidation. Seasonal temperature variations do not affect the ABF system operation. With the ABF system and other operational improvements the sludge production has dropped from 750 g volatile suspended solids (VSS)/kg BOD destroyed (total plant influent) to 550 VSS/kg BOD destroyed. The installation of four ABF biocells at the Bristol WWTP has expanded the capacity of an overloaded installation, provided the means for a cost-effective and compact expansion, and save significant power. (Rochester-PTT)
W91-07899

CENTRIFUGES VS. DISSOLVED-AIR FLOTATION.
Hazen and Sawyer, Raleigh, NC.
G. S. MacConnell, D. S. Harrison, K. W. Kirby, H. Lee, and F. Mousavipour.
Water Environment & Technology WAETEJ, Vol. 3, No. 2, p 60-65, February 1991. 1 fig, 3 tab.

Descriptors: *Centrifugation, *Filtration, *Flotation, *Los Angeles, *Sludge drying, *Wastewater treatment, California, Comparison studies, Electric power costs, Hyperion Treatment Plant, Performance evaluation, Polymers.

The city of Los Angeles (California) Hyperion Treatment Plant operates both high-capacity thickening centrifuges and dissolved-air-flotation thickeners (DAFTs). The city recently conducted full-scale tests comparing two manufacturers' centrifuges with the plant's existing DAFTs. Relative power, reliability, and operational, maintenance, and chemical requirements were compared for the different types of machines. Also compared were design, construction materials, and operation of the two types of centrifuges. Both manufacturers supplied horizontal solid-bowl, scroll-type centrifuges, which were designed to achieve similar process performance with continuous feed. The centrifuges were tested both with and without polymer and the effects of differential speed regulation, influent flow rate, and nozzle area were considered. One centrifuge had 25% unscheduled downtime; the other had 12% unscheduled downtime. Some rust was noted on parts of one centrifuge, but no rust was found on the other centrifuge. The centrifuges were more operationally flexible than the DAFTs because they could be operated over a wider range of feed-sludge total waste activated solids (TWAS) concentration. However, the DAFTs had greater capture efficiency than the centrifuges. Unlike the centrifuges, DAFTs require polymer to perform effectively, and significantly higher doses of polymer are required to obtain similar performance from DAFTs. Centrifuge Two had the lowest power demand (1905 kW/cu m of WAS feed/sec), whereas the DAFT and Centrifuge One required 3016 and 3333 kW/cu m of WAS feed/sec, respectively. (Rochester-PTT)
W91-07900

EVALUATION OF CHEMICAL ADDITION.
CH2M Hill, Santa Ana, CA.
R. Chaudbary, Y. J. Shao, J. Crosse, and F. Soroushian.
Water Environment & Technology WAETEJ, Vol. 3, No. 2, p 66-71, February 1991. 3 fig, 3 tab.

Descriptors: *Chemical treatment, *Los Angeles, *Model studies, *Primary wastewater treatment, *Upgrading, *Wastewater treatment, Biological oxygen demand, California, Hydrogen sulfide, Hyperion Treatment Plant, Odors, Performance evaluation.

The city of Los Angeles is undertaking an upgrade and expansion plan to provide secondary treatment at its Hyperion Treatment Plant (HTP) by 1998. By 1998, HTP will have a 19.7 cu m/sec (450 MGD) secondary treatment capacity using a high-purity-oxygen activated sludge process. One major issue is whether to use chemicals in the primary plant after the plant is converted to a full secondary facility. To investigate the treatment process, a detailed mass balance model was developed. The model provided the flexibility of performing the flow and organic load balances for the existing unit processes and for the unit processes proposed for HTP's secondary facilities. The model was verified using the current plant configuration and operating data. Effect of chemicals on sludge quantities, effect on unit treatment processes, economic effect (capital costs, operations and maintenance cost, and total cost), nonmonetary effects (odor and corrosion control, operational flexibility and reliability, and struvite control), and socioenvironmental effect were examined. For 12 months, the chemically-enhanced primary treatment at HTP has consistently achieved 80% to 85% suspended solids and 55% BOD removal. While the addition of chemicals in the primary plant will increase the annual cost by about $3.7 million, it provides operational flexibility and reliability needed for such a large, politically visible facility. The reduced H2S emissions from the headworks and primary plant help reduce odors and improve relations with neighboring communities. (Rochester-PTT)
W91-07901

TREATMENT OF LEACHATE FROM LANDFILL SITES--STANDARDS, RESULTS OF OPERATION AND COST (LEISTUNGS- UND KOSTENVERGLEICH VON DEPONIESICKERWASSER-RERINIGUNGSANLAGEN MACH DERZEITIGEM STAND DER TECHNIK).
Witten-Herdecke Univ., Witten (Germany, F.R.). Lehrstuhl fuer Umwelttechnik und Umweltmanagement.
For primary bibliographic entry see Field 5E.
W91-07914

RESPIROMETRIC DETERMINATION OF WASTEWATER BIODEGRADATION IN A BIOLOGICAL TREATMENT PLANT.
Kemijski Inst. Boris Kidric, Ljubljana (Yugoslavia).
M. Ros, J. Zagorc-Koncan, M. Dular, and M. Pompe.
Zeitschrift fuer Wasser- und Abwasser Forschung ZWABAQ, Vol. 23, No. 6, p 236-240, December 1990, 7 fig, 2 tab, 24 ref.

Descriptors: *Analytical methods, *Biodegradation, *Biological wastewater treatment, *Oxygen uptake, *Respirometry, *Wastewater analysis, *Wastewater treatment, Activated sludge, Laboratory equipment, Laboratory methods, Measuring instruments, Organic compounds, Respirograms.

The biochemical degradation of wastewater containing degradable organic substances can be estimated by various respirometric methods, such as the dilution method, sapromat method, Warburg method, or with various respirometers. All these methods yield a determination of the biochemical degradation of individual wastewaters, but do not provide information about the actual level of wastewater degradation in a biological treatment plant. An open respirometer was used to determine biochemical degradation for a given wastewater under the conditions which exist in an actual biological treatment plant. Using the respirometer, a respirogram is obtained by adding an exactly-determined amount of wastewater to a suspension of activated sludge in the endogenous phase. The activated sludge is cultivated in a model laboratory treatment plant in which wastewater degradation is studied. From the same respirogram, it is possible to calculate the maximum oxygen uptake rate in the degradation of wastewater and the level of

wastewater degradation in a biological treatment plant. (King-PTT)
W91-07993

SOFTENING BY MEANS OF ION EXCHANGE AND DECREASE OF CONTENT OF NEUTRAL SALT IN SURFACE WATERS (ENTHAERTUNG MIT IONENAUSTAUSCHERN UND VERMINDERUNG DES NEUTRALSALZGEHALTES IN OBERFLAECHENWAESSERN).
CKD, Prague (Czechoslovakia).
For primary bibliographic entry see Field 5F.
W91-07994

FATE OF THE TERPENES ANETHOLE AND DIPENTENE IN A BENCH-SCALE ACTIVATED SLUDGE SYSTEM.
Versar, Inc., Springfield, VA.
S. M. Schwartz, R. S. Boethling, and T. Leighton.
Chemosphere CMSHAF, Vol. 21, No. 10/11, p 1153-1160, 1990. 2 tab, 10 ref.

Descriptors: *Activated sludge treatment, *Gas chromatography, *Organic compounds, *Wastewater analysis, *Wastewater treatment, Biodegradation, Biological treatment, Mass spectrometry, Terpenes.

The fate of the terpenes anethole and dipentene in wastewater treatment was studied using the Organization for Economic Cooperation and Development (OECD) Coupled Units Test, with chemical-specific analysis by gas chromatography/mass spectrometry. Dipentene was removed to below detection limit in both the biologically active (activated sludge) test system and the air stripping control. Thus, the mechanism(s) by which removal occurred in activated sludge could not be determined. Biodegradation and stripping were probably the critical removal processes for anethole, since removal was high in the stripping control but even higher in the active test system, such that anethole was also removed to below the detection limit in the active system. The volatility of anethole was not consistent with its estimated properties. (Author's abstract)
W91-08016

KINETICS OF WET AIR OXIDATION OF PHENOL AND SUBSTITUTED PHENOLS.
Bombay Univ. (India). Dept. of Chemical Technology.
H. S. Joglekar, S. D. Samant, and J. B. Joshi.
Water Research WATRAG, Vol. 25, No. 2, p 135-145, February 1991. 18 fig, 4 tab, 22 ref.

Descriptors: *Oxidation, *Phenols, *Wastewater treatment, *Wet oxidation process, Chemical oxygen demand, Chemical reactions, Energy, Kinetics, Mass transfer, Oxygen, Temperature.

Wet air oxidation (WAO) was carried out on aqueous solutions of phenol and substituted phenols (o, m, and p-chlorophenols, o, m-cresols, o and p-methoxyphenols, o-ethylphenol and 2,6-dimethylphenol). The process was studied in a 1-liter stainless steel autoclave at temperatures in the range of 1500-180 C. The oxygen partial pressure was varied from 0.3 to 1.5 MPa and the initial phenol concentration was 200 mg/L. The oxidation of phenols in water involves a free radical mechanism and proceeds in two steps. The oxidation reaction was found to be first order in oxygen and also first order with respect to phenolic substrates in both steps. The values of activation energy were found to be in the range of 12,400 to 201,000 kJ/kmol. The overall oxidation reaction was found to be reaction-controlled when the temperature was less than 195 C and the phenol concentration was less than 200 mg/L; it became mass transfer-controlled when the temperature was above 240 C and phenol concentration was greater than 20,000 mg/L. The values of mass transfer coefficient have been obtained. The data based on bench scale shows wet air oxidation of phenols can achieve destruction efficiencies exceeding 99.9%. Greater than 90% reduction of chemical oxygen demand was achieved. (Author's abstract)
W91-08047

SIMPLE COMBINATION OF BIODEGRADATION AND CARBON ADSORPTION: THE MECHANISM OF THE BIOLOGICAL ACTIVATED CARBON PROCESS.
Tsinghua Univ., Beijing (China). Dept. of Environmental Engineering.
X. Zhang, Z. Wang, and X. Gu.
Water Research WATRAG, Vol. 25, No. 2, p 165-172, February 1991. 9 fig, 12 ref.

Descriptors: *Activated carbon, *Adsorption, *Advanced wastewater treatment, *Biodegradation, *Wastewater treatment, *Water treatment, Aeration, Biofilters, Biofiltration, Desorption, Enzymes, Filters, Hydrocarbons, Phenols, Respirometry.

Study of the mechanisms of the biological activated carbon (BAC) process reveals that the bioregeneration hypothesis of desorption by exoenzymatic reactions is the common basis for some previous mechanisms. However, the properties of the enzymes involved in the biodegradation of phenols and aromatic hydrocarbons and the distribution of exoenzymes in carbon pores suggest that the hypothesis is not valid in most circumstances. The BAC column test was performed to investigate changes in carbon adsorption capacity during operation with phenol as the pollutant. Biological activity was measured with a Warburg respirometer. A comparison test was also conducted between the BAC bed reactor and biological aerated filters. Results supported the suggestion the mechanism of the BAC process is basically a simple combination of biodegradation and carbon adsorption. It is suggested that some specially designed biological aerated filter, instead of a BAC bed reactor, may be used in advanced wastewater treatment. (Author's abstract)
W91-08050

SULFIDE INHIBITION OF ANAEROBIC DEGRADATION OF LACTATE AND ACETATE.
Manitoba Univ., Winnipeg. Dept. of Civil Engineering.
D. M. McCartney, and J. A. Oleszkiewicz.
Water Research WATRAG, Vol. 25, No. 2, p 203-209, February 1991. 7 fig, 4 tab, 29 ref.

Descriptors: *Acetates, *Anaerobic digestion, *Sulfides, *Sulfur bacteria, *Wastewater treatment, Chemical oxygen demand, Chemical reduction, Hydrogen ion concentration, Hydrogen sulfide, Kinetics, Organic acids, Organic compounds, Sulfates, Sulfur compounds.

Bench scale batch anaerobic degradation of lactate and acetate was investigated using three sets of serum bottles. All serum bottles were fed 1 g/L chemical oxygen demand (COD) and 15.6 mM (1.5 g/L) sulfate at the start of the experiment. Set one used lactic acid, set two used acetic acid, and set three used a 1:1 mixture on a COD basis of the two organic acids. Each set consisted of 10 serum bottles, of which 5 were started at a pH of 7 and 5 at a pH of 8. Each pH subset reactor had a different initial total sulfide (TS) concentration, which varied from 3.13 to 31.3 mM (100-1,000 mg/L). Acetate removal followed first order reaction kinetics and proceeded without any significant sulfate reduction. Inhibition of acetate removal by aqueous hydrogen sulfide was modeled using an exponential function. Both propionate removal and sulfate reduction were inhibited proportionally to the concentration of TS. This suggests a crucial role for the sulfate-reducing bacteria in mediating propionate degradation to acetate. In the low pH subset of set three (the 1:1 mixture), complete inhibition of sulfate reduction occurred at only 17% inhibition of methanogenesis. Complete COD removal occurred in all the serum bottles of the high pH subsets, indicating the important role of H2S in sulfide inhibition. (Author's abstract)
W91-08055

OPTIMUM RESIDENCE TIME (IN CSTR AND AIRLIFT REACTOR) FOR BACTERIAL LEACHING OF METALS FROM ANAEROBIC SEWAGE SLUDGE.
Institut National de la Recherche Scientifique, Sainte-Foy (Quebec).
For primary bibliographic entry see Field 5E.
W91-08056

POLICY, LAW AND IMPLEMENTATION OF INDUSTRIAL WASTEWATER POLLUTION CONTROL.
Central Pollution Control Board, New Delhi (India).
For primary bibliographic entry see Field 5G.
W91-08060

IMPROVED INDUSTRIAL WATER POLLUTION CONTROL IN BOTSWANA: FROM STRATEGY TO PRACTICAL IMPLEMENTATION.
Botswana Dept. of Water Affairs, Gaborone.
For primary bibliographic entry see Field 5G.
W91-08061

COMBINED TREATMENT OF DOMESTIC AND INDUSTRIAL WASTEWATER IN WASTE STABILISATION POND SYSTEMS IN KENYA.
Leeds Univ. (England). Dept. of Civil Engineering.
G. P. Alabaster, S. W. Mills, S. A. Osebe, W. N. Thitai, and H. W. Pearson.
Water Science and Technology WSTED4, Vol. 24, No. 1, p 43-52, 1991. 2 fig, 10 tab, 16 ref.

Descriptors: *Industrial wastes, *Kenya, *Stabilization ponds, *Wastewater treatment, Algae, Anaerobic digestion, Biological oxygen demand, Buffering, Hydrogen ion concentration, Organic carbon, Organic loading, Retention time, Settleable solids, Shock loads, Tannery wastes, Temperature, Textile mill wastes, Tropical regions.

Waste stabilization pond systems have traditionally been used for treating domestic wastewater, although they may also be suitable for treating high-strength industrial wastes. The long retention times and high buffering capacity of such systems enables them to cope more readily with widely fluctuating organic loads and biologically toxic compounds. Two waste stabilization pond systems in Kenya were examined. Both ponds treat sewage containing a high proportion of mixed industrial effluent (tannery and textile wastes). Data from the ponds demonstrated that anaerobic ponds are highly efficient at removing biological oxygen demand (BOD) even at very low retention times. Although this was mostly due to the removal of settleable solids, large reductions in filtered BOD can also be obtained, especially in tropical climates where elevated temperatures lead to high rates of anaerobic digestion. Not only did the ponds significantly reduce the organic carbon content of the wastewaters, but they buffered the sensitive algal populations in the secondary facultative ponds from shock loads of highly toxic chemicals and wastes of widely varying pH. This enabled an overall higher loading to be applied to the aerobic system. It is concluded that anaerobic ponds are ideal for treating high-strength industrial wastes. (Author's abstract)
W91-08064

COFFEE INDUSTRY WASTES.
Helsinki Univ. of Technology, Espoo (Finland). Lab. of Sanitary and Environmental Engineering.
B. Gathuo, P. Rantala, and R. Maatta.
Water Science and Technology WSTED4, Vol. 24, No. 1, p 53-60, 1991. 5 fig, 2 tab, 21 ref.

Descriptors: *Anaerobic digestion, *Coffee wastes, *Food-processing wastes, *Kenya, *Land disposal, *Wastewater treatment, Anaerobic lagoons, Biogas, Biological oxygen demand, Central America, Composting, Energy, India, Seepage pits, Waste stabilization, Water reuse.

The coffee industry is the most important industrial polluter in Kenya, producing pulp, husks, and wastewaters. Husks can be used as fuel. Wet pulp could be composted and used as soil conditioner. Wastewaters have a high biological oxygen demand, sometimes exceeding 9,000 mg/L. Anaerobic lagoons are used to treat these wastewaters in

India and Central America. In Kenya, water reuse combined with land disposal with zero discharge has been recommended. However, it has not been possible to provide adequate seepage pits, and hence there are still effluent discharges into waterways. In addition, this method does not provide for stabilization of the pulp. Anaerobic digestion with biogas production is an attractive alternative, with the fuel generated being used to dry coffee. About 10,000 GJ of energy is required to dry 1 ton of coffee. The potential yield of biogas from 1 ton of pulp is estimated at 131 cu m, which is equivalent to 100 liters of gasoline in fuel value. (Author's abstract)
W91-08065

ANAEROBIC SLUDGE DIGESTION IN INDUSTRIAL WASTEWATER TREATMENT.
Tampere Univ. of Technology (Finland). Inst. of Water and Environmental Engineering.
J. A. Puhakka.
Water Science and Technology WSTED4, Vol. 24, No. 1, p 61-68, 1991. 6 fig, 2 tab, 8 ref.

Descriptors: *Activated sludge process, *Anaerobic digestion, *Pulp wastes, *Sludge digestion, Activated sludge, Alkalinity, Biogas, Chemical oxygen demand, Kraft mills, Methanogenesis, Nitrogen, Organic loading, Organic matter, Phosphorus, Retention time, Sludge, Sludge drying, Temperature, Volatile solids.

Laboratory and pilot-scale experiments were conducted on the anaerobic digestion of waste activated sludge produced in an activated sludge process treating a bleached kraft mill effluent. Chemical oxygen demand was reduced 45%-59% using the batch incubation method at 25 C. Laboratory-scale reactor studies indicated no advantage of thermophilic process over mesophilic. Sludge digestibility was improved by alkaline or alkaline-thermal pretreatment, as indicated by sludge hydrolysis and improved gas production. In pilot tests, anaerobic treatment resulted in volatile solids reduction of 40%-60%. Anaerobic digestion remained stable with organic loading rates from 1.5 to 5.2 kg VS/cu m-d (hydraulic retention time 42 to 8 days). Average biogas production during the 21-month experimental period was 0.54 cu m/cu m reaction space. Anaerobic digestion resulted in deteriorated dewaterability of waste activated sludge in belt filter press tests. (Author's abstract)
W91-08066

HIGH-RATE ANAEROBIC TREATMENT OF INDUSTRIAL WASTEWATERS.
Tampere Univ. of Technology (Finland). Inst. of Water and Environmental Engineering.
J. Rintala.
Water Science and Technology WSTED4, Vol. 24, No. 1, p 69-74, 1991. 4 fig, 8 ref.

Descriptors: *Anaerobic digestion, *Industrial wastes, *Industrial wastewater, *Pulp wastes, *Wastewater treatment, Acetates, Chemical oxygen demand, Filters, Food-processing wastes, Methanol, Sludge, Sugarcane.

Anaerobic mesophilic treatment of synthetic (a mixture of acetate and methanol) and thermomechanical pulping (TMP) wastewaters was studied in laboratory-scale upflow anaerobic sludge blanket (UASB) reactors and filters with emphasis on the process startup. The reactors were inoculated with nongranular sludge. The startup of mesophilic and thermophilic processes inoculated with mesophilic granular sludge was investigated in UASB reactors fed with diluted vinasse. The startup proceeded faster in the filters than in the UASB reactors with TMP and synthetic wastewater. Loading rates of over 15 kg chemical oxygen demand (COD) per cu m per day with 50%-60% COD removal efficiencies were achieved in 10 days in the mesophilic and in 50 days in the thermophilic UASB reactor treating vinasse. The results show that high-rate anaerobic treatment can be applied to different types of industrial wastewaters under varying conditions. (Doria-PTT)
W91-08067

LOW-COST AND HIGH-EFFICIENCY SOLUTION FOR SUGAR FACTORY WASTE WATER TREATMENT.
Technische Univ., Vienna (Austria). Inst. fuer Wasserguete und Landschaftswasserbau.
W. von der Emde, and H. Kroiss.
Water Science and Technology WSTED4, Vol. 24, No. 1, p 75-82, 1991. 7 fig, 5 tab, 3 ref.

Descriptors: *Food processing industry, *Food-processing wastes, *Sugar beets, *Wastewater treatment, *Wastewater utilization, Activated sludge, Aeration, Biological oxygen demand, Biological wastewater treatment, Chemical oxygen demand, Construction, Costs, Economic aspects, Electric power, Electric power costs, Flow, Groundwater, Lagoons, Maintenance costs, Operating costs, Primary sludge, Settling tanks, Shock loads, Standards, Storage, Suspended solids, Temperature, Wastewater facilities, Water consumption.

The Leopoldsdorf (Austria) beet sugar factory illustrates how a very simple and low-cost plant operated during only part of the year can provide high-efficiency wastewater treatment. The plant operates based on the following assumptions: (1) with a lowly loaded activated sludge plant, effluent standards can be met without major wastewater storage capacity (2) wastewater treatment takes place during the processing season when the factory produces low-cost electrical power for aeration, and enough personnel for mechanical and chemical supervision are available; and (3) the treated effluent can be recirculated to replace fresh water, thus reducing groundwater consumption. The excess sludge load from biological treatment is added to the influent of the primary settling tank. The overflow of the sludge settling lagoons is brought back to the treatment plant. There is no discharge of wastewater without biological treatment. The reuse of the biologically treated effluent caused no problems, neither in the factory nor at the treatment plant. The treated effluent could replace the groundwater for several purposes without change in the water scheme of the factory. The only effect of the recirculation was an increase of the temperature level in the wastewater system. The costs of investment and operation were very low. (Doria-PTT)
W91-08068

DAIRY WASTEWATER TREATMENT AND REUSE.
Hydrotech, Limassol (Cyprus).
I. Hadjivassilis.
Water Science and Technology WSTED4, Vol. 24, No. 1, p 83-87, 1991. 1 fig, 4 tab, 6 ref.

Descriptors: *Dairy industry, *Food-processing wastes, *Wastewater treatment, *Wastewater utilization, *Water reuse, Activated sludge process, Biological oxygen demand, Chemical oxygen demand, Coagulation, Cooling water, Cost analysis, Cyprus, Disinfection, Filtration, Flocculation, Irrigation water, Operating costs, Performance evaluation, Tertiary wastewater treatment, Water temperature.

Wastewater treatment can be a profitable activity in semiarid areas if treated water is reused. High-efficiency treatment is desirable for this purpose to produce high effluent water quality. The treatment of dairy wastewater at a plant in Cyprus for reuse as cooling and irrigation water is described. The wastewater (200 cu m/d, 345 kg biological oxygen demand (BOD)/d) is treated by an activated sludge with an oxic selector, followed by high-rate multilayer granular filtration combined with flocculation, and disinfection. Samples were examined monthly for three years to assess plant performance. Water temperature was measured and samples taken after the biological stage and after tertiary treatment. Samples were analyzed for BOD, chemical oxygen demand, suspended solids, turbidity, sulfates, hardness, pH, and chlorine. The operating cost of the plant ranged from $0.38 to $0.42 per cu m. This includes electricity, surplus sludge handling and disposal, maintenance, labor, and chemicals. Design expectations were met fully during three years of plant operation. Activated sludge bulking does not exist, results fulfill required standards, and water is reused without any problems. (Doria-PTT)
W91-08069

APPROPRIATE INDUSTRIAL WASTE MANAGEMENT TECHNOLOGIES: THE NEW ZEALAND MEAT INDUSTRY.
Massey Univ., Palmerston North (New Zealand).
S. M. Rao Bhamidimarri.
Water Science and Technology WSTED4, Vol. 24, No. 1, p 89-95, 1991. 6 tab, 8 ref.

Descriptors: *Animal wastes, *Composting, *Meat processing industry, *New Zealand, *Waste treatment, *Wastewater irrigation, *Wastewater treatment, Aerobic digestion, Biological oxygen demand, Compost, Effluents, Fats, Feces, Fertilizers, Groundwater pollution, Nitrates, Nitrogen, Nutrients, Organic carbon, Phosphorus, Primary wastewater treatment, Proteins, Solid wastes.

New Zealand has developed the concepts of effluent irrigation and aerobic composting of organic solid wastes for effective treatment and resource recovery in meat processing wastes. A typical New Zealand meatworks generates 10,000 cu m/d of effluent with a biological oxygen demand (BOD) of about 1,500 mg/L. In terms of process reliability, treatment efficiency, and resource recovery, effluent irrigation is far superior to other conventional wastewater treatment processes. The organic carbon in the effluent is easily degradable, since long-chain molecules such as fats are removed in primary treatment. Phosphorus is immobilized in soil, but nitrogen is converted to nitrate and may result in groundwater contamination. For solid waste, composting offers the advantages of being environmental acceptable, well understood, and technically simple. It is economically viable on its own, as the compost can be sold as organic fertilizer. Two composting technologies in use are conventional windrow and aerated static pile systems. In both cases, the compost was shown to be better than other commercial composts and potting mixes in terms of plant growth and cost. (Doria-PTT)
W91-08070

TEXTILE INDUSTRY WASTEWATERS TREATMENT.
Vysoka Skola Chemicko-Technologicka, Prague (Czechoslovakia). Inst. of Water Technology and Environmental Protection.
P. Grau.
Water Science and Technology WSTED4, Vol. 24, No. 1, p 97-103, 1991. 2 tab, 18 ref.

Descriptors: *Color removal, *Textile mill wastes, *Wastewater treatment, Activated sludge process, Adsorption, Adsorption-desorption, Anaerobic digestion, Bases, Biological oxygen demand, Biological wastewater treatment, Chemical oxygen demand, Coagulation, Cotton, Dyes, Flocculation, Municipal wastewater, Oxidation, Ozonation, Technology, Wastewater renovation, Wastewater utilization, Water reuse, Wool.

The textile industry today is characterized by the use of continuous, water-saving processes. Wastewater is recycled and reused after intermediate treatment. Improvements in low-waste technology include lanolin recovery in wool scouring, hydroxide recovery in cotton mercerizing, recovery of synthetic sizes, and reuse of dye baths. Traditionally, wastewater is treated by coagulation/flocculation followed by biological treatment; more recently, the reverse sequence of treatments has been utilized with success. Wastewater treatment technology research and development is focusing on efficient decoloration. Novel decoloration technologies include catalytic oxidation, ozonation, and adsorption/desorption. Joint treatment with municipal wastewaters minimizes the need for chemicals for decoloration. Dyes are adsorbed on activated sludge, produced in larger quantity on excessive substrate from municipal wastewater. Surprisingly, anaerobic treatment is rarely reported. (Doria-PTT)
W91-08071

WASTEWATER GROWN WATERHYACINTH AS AN INGREDIENT IN RABBIT FOOD.
Florida Univ., Gainesville. Dept. of Small Animal Clinical Sciences.
A. F. Moreland, B. R. Collins, C. A. Hansen, and R. O'Brien.
Journal of Aquatic Plant Management JAPMDB, Vol. 29, p 32-39, January 1991. 7 tab, 26 ref.

Descriptors: *Aquatic weeds, *Feeds, *Municipal wastewater, *Nutrient removal, *Rabbits, *Wastewater treatment, *Water hyacinth, Analysis of variance, Bioassay, Cadmium, Fertility, Growth, Heavy metals, Lead, Mercury, Survival, Teratogenicity, Tissue analysis, Toxicity, Trace elements.

It has been suggested that water hyacinth be used for the removal of nutrient pollutants from wastewater. Since water hyacinth extract nutrients from the water and store them in their tissues, they become a potentially useful food source. A rabbit ration consisting of 30% alfalfa was modified and two experimental diets formulated to contain 30% water hyacinth and 0% alfalfa, or 20% water hyacinth and 10% alfalfa. These pelleted diets were fed to rabbit for two generations and were palatable, and all animals thrived. First-generation animals consuming the diet containing 30% water hyacinth reached a final mean body weight significantly less (10.62%) than controls; however, there were no significant differences between control and 20% water hyacinth diets. Second-generation animals consuming the diets containing water hyacinth were not significantly different from controls in final mean body weights and overall growth rates were unaffected by the diets in either generation. However, when the growth period was divided into segments, the rate of growth was variable in some time periods. Survivability, fertility, survival of offspring, and teratogenicity were not affected by the diets. Elemental analysis of muscle tissue from the rabbits showed levels below those reported as toxic. (Author's abstract)
W91-08074

SIGNIFICANCE OF FRACTIONATION METHODS IN ASSESSING THE CHEMICAL FORM OF PHOSPHATE ACCUMULATED BY ACTIVATED SLUDGE AND AN ACINETOBACTER PURE CULTURE.
Council for Scientific and Industrial Research, Pretoria (South Africa). Div. of Water Technology.
D. W. de Haas.
Water SA WASADV, Vol. 17, No. 1, p 1-10, January 1991. 7 fig, 3 tab, 38 ref.

Descriptors: *Acinetobacter, *Activated sludge process, *Phosphates, *Separation techniques, *Wastewater analysis, *Wastewater treatment, Bacteria, Chemical analysis, Hydrogen ion concentration, Orthophosphates, South Africa.

Two chemical fractionation procedures aimed at the determination of phosphorus compounds were used to analyze the same activated sludge sample from a 5-stage modified Bardenpho plant in South Africa. In both procedures, at least 14% of the total phosphorus was measured as orthophosphate. It was concluded that chemical precipitates or orthophosphate can form naturally in modified activated sludge systems not dosed with chemical precipitants. Different chain lengths of polyphosphate were measured in trichloroacetic and in perchloric acid extracts of the same sample. The chain lengths of polyphosphate measured in subsequent (alkaline) steps were not greater than those found in the acid step. Therefore, it was concluded that classification of acid-soluble polyphosphate as 'low molecular' and acid-insoluble polyphosphate as 'high molecular' is not justified. Also, quantification of acid-soluble and acid-insoluble polyphosphate extracted from activated sludge was challenged, since it was found that the distribution of polyphosphate between the two fractions was influenced by the nature of the extractant and by hydrolysis of polyphosphate to orthophosphate during extraction. It was also determined that metabolic studies of polyphosphate formation by Acinetobacter should be conducted in a medium with near-neutral pH. (Author's abstract)
W91-08087

INSTRUMENT FOR THE DIRECT DETERMINATION OF OXYGEN UTILISATION RATE.
Cape Town Univ. (South Africa). Dept. of Chemical Engineering.
For primary bibliographic entry see Field 7B.
W91-08088

LONG-CHAIN FATTY ACID, OLEATE, AS SOLE SUBSTRATE IN UPFLOW ANAEROBIC SLUDGE BED (UASB) REACTOR SYSTEMS.
Cape Town Univ. (South Africa). Dept. of Civil Engineering.
P. A. L. N. S. Sam-Soon, R. E. Loewenthal, M. C. Wenzel, and G. R. Marais.
Water SA WASADV, Vol. 17, No. 1, p 31-36, January 1991. 4 fig, 17 ref.

Descriptors: *Anaerobic digestion, *Dairy industry, *Lipids, *Sludge, *Wastewater treatment, Acetic acid, Acidity, Ammonium, Fatty acids, Metabolism, Nitrogen.

The response of an upflow anaerobic sludge bed (UASB) reactor system to an influent with the salt of a long-chain fatty acid, oleic acid, as sole substrate was investigated. Only acetic acid was generated, indicating that the metabolic pathway producing acetic acid only was the predominant one. This pathway operates under conditions of low pH. Accepting that pH was low, one of the requirements for pelletization was not fulfilled. Non-pellet forming behavior was confirmed by lack of pellet production; the low uptake of ammonium-nitrogen; and the low production of organic nitrogen in the bed. Thus, the prediction that pelletization is not to be expected with lipids as influent is supported. Moreover, a well-defined sludge bed was formed, but of a gelatinous texture. This type of bed and its texture appears to be very similar to that obtained in an UASB system treating an olive oil processing wastewater. It is concluded that treatment of liquid wastes having an appreciable lipid concentrations (for example from dairies and abattoirs) may give rise to beds with both pelletized and gelatinous material present. Whether the system will operate effectively will need to be established experimentally. (See also W91-0891 and W91-0892) (Doria-PTT)
W91-08090

EFFECTS OF A RECYCLE IN UPFLOW ANAEROBIC SLUDGE BED (UASB) SYSTEMS.
Cape Town Univ. (South Africa). Dept. of Civil Engineering.
P. A. L. N. S. Sam-Soon, R. E. Loewenthal, M. C. Wentzel, R. E. Moosbrugger, and G. R. Marais.
Water SA WASADV, Vol. 17, No. 1, p 37-46, January 1991. 8 fig, 3 tab, 11 ref.

Descriptors: *Anaerobic digestion, *Carbohydrates, *Food-processing wastes, *Sludge, *Wastewater treatment, Alkalinity, Chemical oxygen demand, Hydrogen ion concentration, Sludge bed.

Two major problems arise in the operation of upflow anaerobic sludge bed (UASB) reactor systems treating carbohydrate wastes: high influent chemical oxygen demand (COD) and inadequate influent alkalinity/influent COD. These cause the minimum pH in the bed to decline to below 6.6, which can lead to failure of the system. The use of a recycle from the effluent to the influent to reduce the influent alkalinity requirements per influent COD, and to reduce the effective influent concentration was investigated. In flow-through systems treating a carbohydrate waste, minimum influent alkalinity requirement is about 1.2 mg (as CaCO3)/mg influent COD. The minimum influent alkalinity requirement can be reduced by imposing a recycle, the reduced requirement given by 1.2 X base flow/(base + recycle flow) mg alkalinity (as CaCO3)/mg influent COD. The effective influent COD concentration is correspondingly reduced. At or near the maximum sludge rate, the recycle may have an adverse effect on system performance; it interactively increases the loading rate above the maximum by recycling short-chain fatty acids and COD that 'leak' through the sludge bed. (See also W91-08090 and W91-08092) (Author's abstract)
W91-08091

EFFECT OF SULPHATE ON PELLETISATION IN THE UASB SYSTEM WITH GLUCOSE AS THE SUBSTRATE.
Cape Town Univ. (South Africa). Dept. of Civil Engineering.
P. A. L. N. S. Sam-Soon, R. E. Loewenthal, M. C. Wentzel, and G. R. Marais.
Water SA WASADV, Vol. 17, No. 1, p 47-56, January 1991. 9 fig, 2 tab, 11 ref.

Descriptors: *Anaerobic digestion, *Food-processing wastes, *Glucose, *Sludge, *Sulfates, *Wastewater treatment, Chemical oxygen demand, Chemical reduction, Hydrogen, Methanogenesis, Suspended solids, Volatile solids.

The response of an upflow anaerobic sludge bed (UASB) reactor system to a glucose substrate when dosed with different concentrations of sulfate was investigated. With glucose and sulfate at a low influent sulfate/chemical oxygen demand (COD) ratio, virtually all the sulfate was reduced. Above some upper influent sulfate/COD ratio, the mass of sulfate reduced became virtually constant at 0.12 mg sulfate/mg influent COD. As the influent sulfate/COD ratio increased from a low value so pellet formation concomitantly decreased, from +/-0.08 mg volatile suspended solids (VSS)/mg influent COD at trace influent sulfate concentration, to 0.04 mg VSS/mg influent COD at excess influent sulfate concentration. The lower pellet production is proposed to be due to competition for H2 substrate between the hydrogenotrophic methanogens and sulfidogens. However, the kinetics of H2 utilization reported in the literature for these two species in chemostats do not provide a consistent explanation for the behavior observed in the UASB systems; possibly the structure of the pellet itself, or the distribution of organisms in the pellet, influences their respective rates of H2 utilization. (See also W91-08090 and W91-08091) (Author's abstract)
W91-08092

OPTIMIZATION OF COAGULATION AND FLOCCULATION IN THE TREATMENT OF OIL-SYNTHESIS WASTEWATER (OPTIMERING VAN KOAGULASIE EN FLOKKULASIE IN DIE HERWINNING VAN KOELWATER UIT OLIESINTESE-AFVALWATER).
Pretoria Univ. (South Africa). Dept. of Chemical Engineering.
J. van Leeuwen, and P. Wille.
Water SA WASADV, Vol. 17, No. 1, p 83-90, January 1991. 12 fig, 7 ref. English summary.

Descriptors: *Activated sludge process, *Coagulation, *Flocculation, *Oil wastes, *Wastewater treatment, Bacteria, Bentonite, Chlorides, Clarification, Colloids, Effluents, Filtration, Polyelectrolytes, Sand filters, Sedimentation, Turbidity, Zeta potential.

The activated sludge process, which is used in the purification of an oil synthesis effluent, produces an effluent high in turbidity. The water also contains a lot of dispersed bacterial growth which is not removed during sedimentation. Flocculation is essential to remove these materials. The average diameter of the colloids was found to be 0.92 microns. The zeta potential of the colloids was determined in an attempt to correlate it to the amount of flocculant required. The value was relatively constant at -13.88 mV, which indicates that a cationic coagulant is required. The required dosage to achieve clarification by means of sedimentation only was very high. Both the recirculation of flocs and the addition of bentonite reduced the required dosage drastically. The use of flocculant aids led to small reductions in flocculant dose and cost. Ferric chloride as a primary coagulant, followed by the addition of polyelectrolyte, led to large savings in certain cases. Large reductions in flocculant dosage were obtained by the additional use of sand filtration to remove smaller flocs. (Author's abstract)
W91-08096

WASTEWATER TREATMENT MODEL FOR WASTE HEAT UTILIZATION ASSESSMENT.

R. N. Amundsen, and J. D. Keenan.
Journal of Environmental Systems JEVSBH, Vol. 20, No. 1, p 23-52, 1990/1. 4 fig, 5 tab, 42 ref.

Descriptors: *Aquaculture, *Biotechnology, *Hydroponics, *Mass balance, *Model studies, *Waste heat, *Wastewater treatment, Aeration, Aerobic digestion, Algae, Anaerobic digestion, Clams, Crayfish, Pollution control, Recycling, Water hyacinth.

Thermal effluents from power plants can be used to accelerate the treatment of wastewater. Under controlled temperature conditions, retention time in anaerobic digesters and oxidation ponds is minimized. Models for simulating the performance of anaerobic digesters, algae ponds, and the U-tube aeration system have been developed. It was concluded that the U-tube aerator has by far the highest energy efficiency of the aeration systems used in aquaculture. It also has low maintenance and space requirements, along with low construction costs. Using the models developed material balances were determined for the fermentation of water hyacinths into ethanol and the production of clams and crayfish; heat balances were calculated for an anaerobic digester and for a water hyacinth pond with a protective plastic cover; and flow requirements were determined from both oxygen replenishment and metabolite reduction perspectives. Livestock manure and municipal wastewater can yield methane through anaerobic digestion, and ethanol through fermentation of water hyacinths grown in wastewater. The nutrient-laden effluents can be used to produce algae, which serves as food for freshwater clams and crayfish. By simulating the biological treatment of wastewater as part of an integrated waste heat utilization complex, it is possible to evaluate the benefits of thermal enrichment in terms of the valuable byproducts and waste treatment services provided. (Author's abstract)
W91-08111

BOUNDARY CONDITIONS FOR THE WASTE STABILIZATION POND.
Nigeria Univ., Nsukka. Dept. of Civil Engineering.
J. C. Agunwamba.
Water, Air and Soil Pollution WAPLAC, Vol. 52, No. 3/4, p 237-245, 1990. 2 fig, 3 tab, 15 ref.

Descriptors: *Boundary conditions, *Coliforms, *Flow models, *Model studies, *Stabilization ponds, *Wastewater treatment, Bacterial productivity, Comparison studies, Statistical analysis.

Two different solutions of the dispersed flow model of the waste stabilization pond based on two different sets of boundary conditions were compared and analyzed statistically. These solutions used in the prediction of the coliform reduction in the pond, were based on Hulbult's and Danckwerts' sets of boundary conditions. Although Danckwertts' set of boundary conditions is more mathematically consistent than Hulbult's, the solution based on the latter is simplier. Besides, statistical analysis at the 0.01 level of significance showed that there is little to choose between the two in terms of accuracy. Also the two solutions gave similar values of correlation coefficient, standard error, intercept and regressed slope. (Author's abstract)
W91-08116

COMPREHENSIVE SLUDGE MANAGEMENT PLANNING FOR THE HYPERION TREATMENT PLANT (LOS ANGELES, USA).
Montgomery (James M.) Consulting Engineers, Inc., Pasadena, CA.
D. S. Harrison, B. M. Smith, and J. T. Crosse.
Water Science and Technology WSTED4, Vol. 22, No. 12, p 7-22, 1990. 9 fig, 5 tab, 2 ref.

Descriptors: *California, *Management planning, *Sludge disposal, *Sludge management, *Sludge utilization, *Wastewater treatment, Digester gas, Digesters, Hyperion Treatment Plant, Los Angeles, Ocean dumping, Prediction.

The City of Los Angeles Hyperion Treatment Plant currently processes 1.44 million cu m/day of flow with a secondary treatment capacity of 0.719 million cu m/day. The City ceased ocean dumping of sludge in November 1987 and will upgrade the plant's capacity to 1.7 million cu m/day, with full secondary treatment, by 1998. The cessation of ocean discharge and the anticipated increase in sludge quantities led to the formulation of a Sludge Management Plan to address sludge processing facility needs on-site and off-site options for reuse/disposal of dewatered sludge cake or sludge combustion ash. Planning from sludge management began in March 1988 and a planning report was issued in January 1989. The main objectives of the sludge management planning effort were: develop projected sludge quantities; develop a sludge reuse program; and determine sludge processing needs. Among the planning documents prepared during the management planning process were the following: flow projections; process flow chart; sludge production projections; effect of chemical addition on sludge production for 450 mgd flow; digester gas projections; plant layout designs (present and future); expansion plan for 2.5-million gallon egg-shaped digesters, and digester gas utilization plan. (Rochester-PTT)
W91-08125

SLUDGE MANAGEMENT AND DISPOSAL PRACTICES OF THE COUNTY SANITATION DISTRICTS OF LOS ANGELES (USA).
Los Angeles County Sanitation Districts, Whittier, CA.
C. W. Carry, J. F. Stahl, B. E. Hansen, and P. L. Friess.
Water Science and Technology WSTED4, Vol. 22, No. 12, p 23-32, 1990. 4 fig, 2 tab.

Descriptors: *California, *Sludge disposal, *Sludge management, *Sludge utilization, *Waste disposal, *Wastewater treatment, Digested sludge, Incineration, Landfill gas, Los Angeles, Operating policies, Soil amendments.

The County Sanitation Districts of Los Angeles County (California) operate a network of six wastewater treatment plants called the Joint Outfall System (JOS) which treat a wastewater flow of approximately 22.3 cu m/sec (510 mgd). Centralized sludge processing for the JOS is performed at the largest plant in the system, the Joint Water Pollution Control Plant (JWPCP). Sludge is anaerobically digested, dewatered in scroll centrifuges, and either composted and sold to a private company that produces bagged soil amendment products or codisposed with refuse at a site that recovers energy from landfill gas with a 46 MW (net) steam turbine power plant. Future sludge handling will include dehydration followed by incineration for most of the sludge now landfilled. JWPCP accomplishes an environmentally sound and cost-effective balance of solids disposal to air, land, and water. (Author's abstract)
W91-08126

MANAGING CHANGE IN AN ENVIRONMENTALLY CONSCIOUS SOCIETY: A CASE STUDY, GOTHENBURG (SWEDEN).
Goeteborg Regional Sewerage Co. (Sweden).
For primary bibliographic entry see Field 5E.
W91-08128

DRYING OF SEWAGE SLUDGE: AN IMPORTANT STEP IN WASTE DISPOSAL.
Ingenieurbuero fuer Verfahrens- und Chemieingenieurtechnik, Zurich (Switzerland).
H. Gruter, M. Matter, K. H. Oehlmann, and M. D. Hicks.
Water Science and Technology WSTED4, Vol. 22, No. 12, p 57-63, 1990. 8 fig, 4 tab.

Descriptors: *Germany, *Sludge drying, *Switzerland, *Thin-film evaporation, *Waste disposal, *Waste management, Cost analysis, Fertilizers, Incineration, Performance evaluation, Sludge disposal, Sludge solids.

In both Germany and Switzerland, alternatives for sludge disposal are being foreclosed due to decreasing land availability and concerns about spreading toxic compounds in the environment. One way to reduce sludge volume would be to employ thin-film evaporation (TFE) technology in drying. TFE has been used for 25 yr industrial drying and the first tests of sludge drying were conducted 15 yr ago. The combination of continuous TFE with continuous disc dryer as a second stage is an ideal solution that leads to very high solids content. Depending on the final stage (e.g., direct incineration, storage for incineration fuel, or storage for fertilizer), the sludge can be dried to 40-60% solids content (SC) for incineration and up to 90% SC for storage. The Buss sludge drying system employs a DAS-type thin film dryer as the first stage and a Rovactor disc drier, which has hours of retention time, as the second stage. The DAS alone is sufficient if sludge is to be incinerated to produce steam. Among the desirable characteristics of this system are lack of air pollution with solid particles or odors and continuous operation with a minimum of maintenance. A cost study showed expenses of 71 Swiss francs per ton of sludge (25% SC) based on a sludge flow rate of 4000 kg/hr. (Rochester-PTT)
W91-08129

ODOR NUISANCES CREATED BY SLUDGE TREATMENT: PROBLEMS AND SOLUTIONS.
Centre de Recherche de Maisons-Laffitte (France).
C. Bonnin, A. Laborie, and H. Paillard.
Water Science and Technology WSTED4, Vol. 22, No. 12, p 65-74, 1990. 1 fig, 8 tab, 8 ref.

Descriptors: *Biochemistry, *Odor control, *Odors, *Organoleptic properties, *Sludge treatment, *Waste management, *Wastewater treatment, Air pollution, Centrifuges, Chemical wastewater treatment, Filters, France, Public nuisance.

In sewage treatment plants, the sludge treatment lines generate odor nuisances. Odors are caused mainly by sulfurous compounds (H2S, mercaptans, and organic sulfides), nitrous compounds (ammonia and organic nitrogen), and acid, aldehyde and ketone-type compounds. Air was sampled near the treatment units at 12 sewage works in France. The reasons for the formation of odor-generating compounds were explained for each facility. The main sources of bad smells are the thickeners (H2S, CH3SH, and NH3), thermal processing (H2S and acetaldehyde), dewatering (H2S and NH3), storage (NH3 if final stabilization with lime is applied). Preventive techniques that make it possible to reduce odorous emissions include producing as stable a sludge as possible prior to thickening and dewatering, use of centrifuge or press filter rather than a belt filter for dewatering, and reducing the residence time in the thickening step to under 48 hr. Curative measures consist of roofing the structures and treating the air extracted. A comparative study demonstrated that chemical scrubbing and biodeodorization had good performance levels. Both methods are coming into general use in France for industrial applications. (Author's abstract)
W91-08130

LARGE-SCALE SEWAGE SLUDGE COMPOSTING: A CASE FOR MAINTAINING A DIVERSIFIED PROGRAM.
Philadelphia Water Dept., PA. Sludge Management Unit.
W. E. Toffey.
Water Science and Technology WSTED4, Vol. 22, No. 12, p 107-116, 1990.

Descriptors: *Composting, *Sludge management, *Sludge utilization, *Waste management, *Wastewater treatment, Land application, Land reclamation, Marketing, Odor control, Philadelphia, Sludge solids, Soil amendments.

The Philadelphia Water Department operates the world's largest sewage sludge composting plant. This $80 million plant handles anaerobically digested sewage sludge generated by three regional sewage treatment plants treating 530 million gallons of wastewater daily. The plant was designed to compost sludge solids in an aerated sludge static pile system of composting. During 1989, the plant

composted the full 60,000 dry tons of sludge solids it received for processing. In the future, not all incoming sludge solids will be composted. Instead, a diversified sludge utilization plan will be implemented for the following reasons: (1) the practicable composting capacity is about two-fifths of design capacity; (2) facility managers have been compelled to consider limiting compost production as an odor control strategy; (3) commercial markets for sludge compost have not grown as quickly as the increased production capacity; (4) programs to use or dispose of uncomposted sludge solids are implementable and cost-effective; and (5) and reliance on a single technology or end use is unacceptably risky. The planned distribution of sludge products for calendar year 1990, by proportion of totals solids and by product weight, consists of: (1) marketing of screened compost (33%, 36,000 metric tons); (2) stripmine reclamation with cake/compost mix (20%, 45,000 metric tons); (3) landfill disposal of sludge cake (17%, 64,000 metric tons); (4) agricultural use of compost (15%, 40,000 metric tons); (5) agricultural use of sludge cake (10%, 27,000 metric tons); (6) land reclamation use of compost (3%, 10,000 metric tons); and (7) local application of compost (2%, 5,000 metric tons). (Author's abstract)
W91-08134

EFFECT OF SHEAR ON CONDITIONING: CHEMICAL REQUIREMENTS DURING MECHANICAL SLUDGE DEWATERING.
Virginia Polytechnic Inst., Blacksburg. Dept. of Civil Engineering.
J. T. Novak, and D. P. Lynch.
Water Science and Technology WSTED4, Vol. 22, No. 12, p 117-124, 1990. 11 fig, 5 ref.

Descriptors: *Chemical wastewater treatment, *Physical treatment, *Shear, *Sludge conditioning, Filter presses, Filtration, Fluid flow, Laboratory methods, Polymers, Simulation analysis, Sludge drying.

Many sludges deteriorate or disaggregate when subjected to shear. As a result, sludges dewater more poorly and require much larger chemical conditioning doses to overcome the effects of shear. The shear associated with dewatering processes can be estimated by two approaches: (1) calculations can be made of the shear in filter cakes considering fluid flow and (2) the performance of equipment can be compared with laboratory shear measurements. Both approaches were used in the present study, which was performed with a plate and frame 'J' filter press using conditioned sludge. The results suggested that shear occurring during mechanical dewatering is substantial and can increase the need for polymer conditioning. It appears that the shear in dewatering processes can be simulated using laboratory equipment to permit selection of conditioning chemicals and appropriate doses using laboratory mixing devices. Refiltration of sludges appears to be a useful way to evaluate the effect of polymers on the sludge resistance to shear. (Rochester-PTT)
W91-08135

IN SITU EXAMINATION OF EFFECTS OF PRESSURE DIFFERENTIAL ON COMPRESSIBLE CAKE FILTRATION.
Cornell Univ., Ithaca, NY. School of Civil and Environmental Engineering.
B. R. Bierck, and R. I. Dick.
Water Science and Technology WSTED4, Vol. 22, No. 12, p 125-134, 1990. 9 fig, 17 ref.

Descriptors: *Filtration, *Sludge cake, *Sludge drying, *Sludge filters, *Wastewater treatment, Activated sludge, Compression, Kaolinite, Porous media, Stress analysis, Suspended solids, X-ray absorbance.

When sludges are filtered, an increase in pressure differential does not necessarily cause an increase in filtration rate. The synchrotron x-ray absorbance technique was used to monitor suspended solids concentration changes in compressible filter cakes formed at different constant pressure differentials. Results for a kaolin slurry and an activated sludge manifested the markedly higher compressibility of the latter sludge. A model developed to describe effects of pressure differential on filtrate production behavior of an ideal compressible slurry indicated that the kaolin slurry behaved as such. However, the activated sludge was not ideal because changes in pressure differential did not cause the idealized change in filtrate production rate. A thin skin of activated sludge solids at the filter medium accounted for the non-ideal compressive behavior. Porewater pressure data acquired 0.86 mm above the filter medium during activated sludge filtration provided evidence of skin formation and its effect: virtually the total pressure drop occurred within this 0.86-mm region throughout cake formation (after which shrinkage began). Hence, significant effective stresses required to consolidate the sludge cake did not develop in most of the cake until cake formation was complete and shrinkage began. (Author's abstract)
W91-08136

MOISTURE DISTRIBUTION IN SLUDGES.
Camp, Dresser and McKee, Inc., Raleigh, NC.
K. R. Tsang, and P. A. Vesilind.
Water Science and Technology WSTED4, Vol. 22, No. 12, p 135-142, 1990. 3 fig, 4 tab, 14 ref.

Descriptors: *Moisture content, *Sludge analysis, *Sludge conditioning, *Sludge drying, *Wastewater treatment, Centrifugation, Comparison studies, Filtration, Interstitial water, Laboratory methods, Sludge cake.

It is well known that sludges tend to bind with water and refuse to yield water during dewatering. Attempts have been made to define and measure this water, but no standard method and procedure is available. A drying procedure to measure moisture distribution in sludge was developed and the effects of different conditioning techniques and dewatering procedures on moisture distribution were evaluated. By studying the drying characteristic curve, the moisture in sludge was classified into four categories: free moisture, interstitial moisture, surface moisture, and bound moisture. The effects of three dewatering processes, gravity drainage, vacuum filtration, and centrifugation, as well as chemical conditioning by cationic polymer and physical conditioning by freeze-thaw on the moisture distribution, were investigated. The dewatering procedures removed only part of the free and interstitial moisture; surface and bound moisture were not affected. Part of the free and interstitial moisture also remains with the sludge cake, which can be considered as the inherent inefficiency of the dewatering process. The complete removal of all the free moisture can be considered as the theoretical best performance any mechanical dewatering device can achieve. Polymer addition improved the dewaterability of the sludge by reducing the inherent inefficiency, primarily by reducing the amount of free moisture retained in the cake. Freeze-thaw is found to effect the removal of free, interstitial and surface moisture, bringing about a dramatic increase in dewaterability. The treated sludge cake drains readily and retains no free moisture. (Author's abstract)
W91-08137

CHARACTERISTICS OF SEWAGE SLUDGE AFFECTING DEWATERING BY BELT PRESS FILTER.
Kurita Water Industries Ltd., Atsugi (Japan).
M. Hashimoto, and M. Hiraoka.
Water Science and Technology WSTED4, Vol. 22, No. 12, p 143-152, 1990. 6 fig, 4 tab, 19 ref.

Descriptors: *Filter presses, *Filtration, *Sludge conditioning, *Sludge drying, *Wastewater treatment, Chemical wastewater treatment, Electrical charge, Polyelectrolytes, Sludge cake, Sludge management, Viscosity.

Dewatering characteristics of sewage sludge were determined by conditioning the sludge with the most effective cationic polyelectrolyte among 14 examined and dewatering with a belt press filter. The characteristics of sludges (16 mixed and 8 anaerobically digested) were measured for 33 chemical and physical properties affecting dewaterability. A factor affecting the gravitational filterability of conditioned sludge is the suspended solids concentration of raw sludge. A factor affecting the moisture content of dewatered sludge cake is viscosity of the sludge adjusted to 4.0% of suspended solids concentration. Factors affecting the viscosity are the intrinsic viscosity of alkaline extracts, the ratio of volatile suspended solids-fiber/suspended solids:ash/suspended solids:fiber/suspended solids, and the charge density of sludge particles. A factor affecting the extension degree of dewatered sludge cake is the charge density of sludge particles. Factors affecting the amount of residual solids on the filter cloths are the charge density of sludge particles and the fibrous substances content of the sludge. As for polyelectrolytes, a highly cationized polyelectrolyte is effective to lower the moisture content, the extension degree, and the amount of residual solids on filter cloths. And a factor affecting the required dosage of a polyelectrolyte is anionic substances content in the liquid of raw sludge. (Author's abstract)
W91-08138

EVALUATION OF MUNICIPAL SLUDGE DRYING AND DEWATERING WITH RESPECT TO SLUDGE VOLUME REDUCTION.
Council for Scientific and Industrial Research, Pretoria (South Africa). Div. of Water Technology.
M. Smollen.
Water Science and Technology WSTED4, Vol. 22, No. 12, p 153-161, 1990. 4 fig, 3 tab, 9 ref.

Descriptors: *Moisture, *Moisture content, *Municipal wastewater, *Sludge drying, *Sludge management, *Waste management, *Wastewater treatment, Bound water, Centrifugation, Chemical wastewater treatment, Polyelectrolytes, Sludge cake, Sludge conditioning, Sludge volume index.

A number of factors that influence sludge dewatering behavior have been identified, but there is a lack of consensus which of these are of the greatest concern in sludge treatment strategies. Moisture retention characteristics were obtained from vacuum drying of centrifuged sludge samples to subdivide moisture into immobilized, physically, and chemically bound fractions. Physically bound moisture is responsible for unsatisfactory dewatering by centrifugation. Polyelectrolyte releases some of the immobilized water, but simultaneously increases the physically bound moisture content, which gives rise to large energy inputs during mechanical dewatering. This behavior seems to explain the problems experienced in practice with unsatisfactory low-cake solids concentration obtained with the use of mechanical dewatering equipment. Existing dewatering parameters such as specific resistance to filtration and capillary suction time do not correlate with chemically-bound, physically-bound, and immobilized moisture fractions. These tests give information on an un-immobilized water fraction. They give no information on the ease of removal of the bound moisture fraction. In centrifugal dewatering, the bound moisture content gives the highest correlation with the final cake moisture content. (Rochester-PTT)
W91-08139

MODELS OF SEWAGE SLUDGE CONDITIONING.
Istituto di Ricerca sulle Acque, Bari (Italy).
V. Lotito, G. Mininni, and L. Spinosa.
Water Science and Technology WSTED4, Vol. 22, No. 12, p 163-172, 1990. 3 fig, 6 tab, 7 ref.

Descriptors: *Centrifugation, *Filtration, *Sludge conditioning, *Sludge drying, *Sludge management, *Testing procedures, Laboratory methods, Performance evaluation, Physical models, Pilot plants, Sludge cake, Sludge solids.

Models of sewage sludge conditioning are needed to assess the preferred types of chemicals and the optimal dosages. Laboratory and pilot tests were carried out with organic and inorganic chemicals to determine their influence on sludge parameters and equipment performance. A new parameter, 'specific resistance to centrifugation (Rc)' was developed for evaluating sludge centrifugability. The pilot tests confirmed that satisfactory solids recov-

eries can be obtained when the value of this parameter is around 20-30 sec. Rc was correlated with dosage, molecular weight, and charge density of the polyelectrolytes. Other correlations were determined for specific resistance to filtration and compressibility coefficient. In conditioning using organic chemicals, ferric chloride influenced mainly the specific resistance, whereas lime influence the compressibility coefficient. In response to some discrepancies between the classical theory of infiltration and actual results of pilot tests, a new parameter called 'average specific resistance to filtration' was proposed. A laboratory test applicable to beltpress operation was developed to allow the drainage and compression phases to be simulated. The final cake concentration can be predicted, with good agreement between predictions and experimental values. (Author's abstract)
W91-08140

COST-EFFECTIVE DEWATERING OF MUNICIPAL TREATMENT PLANT SLUDGES USING BELT PRESSES.
Clarke Co., Anaheim, CA.
W. N. Clarke, E. Hodges, and R. J. Ooten.
Water Science and Technology WSTED4, Vol. 22, No. 12, p 173-182, 1990. 5 tab.

Descriptors: *California, *Cost analysis, *Filter presses, *Sludge drying, *Sludge management, *Wastewater treatment, Activated sludge, Filtration, Hydrogen sulfide, Performance evaluation, Polymers, Potassium permanganate, Sludge cake.

An evaluation was conducted at the County Sanitation Districts of Orange County (CSDOC), California, that led to the purchase and installation of the belt filter presses currently in use. The CSDOC operates 8 presses at its Plant No. 1 and 15 presses at its plant No. 2. This equipment was chosen after an exhaustive search and study of all known belt filter press facilities. Over a period of years, the CSDOC acquired 23 Winklepresses after first comparing centrifuges, filter presses, and belt presses in field tests. An early problem was excessive H2S, which exceeded 25 ppm until potassium permanganate feed was added. Liquid polymer is used at a dosage averaging six pounds per ton. Cake dryness depends on the feed sludge composition, density, and feed rate. Primary sludge dewaters to 28% solids, whereas a 70/30 blend of primary and air waste activated sludge will produce 24% solids; and a 50/50 blend dewaters to 18-19%. Pure air waste activated sludge dewaters to 12-13%. Belt tension is set at 400 psi, which is a tradeoff between greater cake thickness and reduced belt life. Two crews of four persons are devoted to mechanical maintenance of the dewatering portion of the treatment plants (belt presses, dewatering buildings, and solids loading and handling). The cleaner machines are kept, the fewer repairs are needed. Belt life is typically 6000 hours. A doctor blade with a pliable tip seems to be an improvement over hard plastic blades. Specific electrical maintenance problems have occurred in the areas of limit switches, motor drives, control panels, and buttons, switches, and alarms. Moisture and corrosion were the main causes of these problems. Instrumentation problems have been few and minor. (Rochester-PTT)
W91-08141

SUCCESSFUL DEWATERING EXPERIENCE AT HYPERION WASTEWATER TREATMENT PLANT.
Los Angeles City Hyperion Treatment Plant, Playa Del Rey, CA.
B. K. Horenstein, G. L. Hernandez, G. Rasberry, and J. Crosse.
Water Science and Technology WSTED4, Vol. 22, No. 12, p 183-191, 1990. 8 fig, 1 tab, 2 ref.

Descriptors: *California, *Centrifugation, *Los Angeles, *Sludge conditioning, *Sludge drying, *Sludge management, Carbon dioxide, Cost analysis, Optimization, Performance evaluation, Sludge disposal, Struvite.

The City of Los Angeles (California) has developed a diversified sludge management program since cessation of the ocean disposal of sludge in 1987. At the heart of this program is the centrifugal dewatering of digested sludge at the Hyperion Wastewater Treatment Plant (HTP). The experience gained from sludge dewatering includes: centrifuge startup problem solving; optimization of the dewatering process; polymer testing; struvite monitoring and control; and development of parameters for waste activated sludge dewatering. Thirteen dewatering centrifuges began to be used in 1985. Numerous adjustments had to be made, including additional tungsten-carbide parts and linings of parts to limit wear. A key to the successful operation of the centrifuges has been the flexibility built into this system with control capabilities that include: local, remote, manual, and automatic functions. The controls employ a system of magmeters and control valves on each centrifuge for sludge and polymer feed to determine the demand of sludge and polymer by common variable speed pumps. At HTP, a 1% increase or decrease in cake solids translates to a $1 million increase or decrease, respectively, in off-site disposal costs. Studies of chemical addition demonstrated that a change in the type of polymer (from mannich to emulsions) allows the machines to be run at a lower differential speed (4.0.-4.5 rpm), resulting in a significant increase in cake solids concentration while maintaining quality above 95% capture. Although polymer cost is substantially higher, the overall cost is lower because sludge disposal cost is reduced by an even greater amount. A major operational problem at HTP is the precipitation of magnesium ammonium phosphate (struvite). HTP has a long history of diluting the sludge streams with plant effluent to reduce the concentration of struvite constituents. Recent investigations suggest that CO2 addition may control pH for struvite mitigation. (Rochester-PTT)
W91-08142

SOLAR ENERGY FOR SLUDGE DRYING IN ALEXANDRIA METROPOLITAN AREA: CASE STUDY IN EGYPT.
Alexandria Univ. (Egypt). Higher Inst. of Public Health.
A. A. Hossam, S. G. Saad, H. H. Mitwally, L. M. Saad, and L. Noufal.
Water Science and Technology WSTED4, Vol. 22, No. 12, p 193-204, 1990. 11 fig, 3 tab, 7 ref.

Descriptors: *Egypt, *Sludge drying, *Sludge management, *Solar energy, *Waste management, *Wastewater treatment, Alexandria, Chemical wastewater treatment, Comparison studies, Cost analysis, Lime, Parasites, Pilot plants, Seasonal variation, Sludge conditioning.

Egypt has an abundance of solar energy, on the order of 5 to 8 kWh/sq m per day, and a sunshine duration of over 4000 hr/yr. With this in mind an experimental study was conducted to assess the drainability of sludge generated by different treatment processes, and to assess a pilot solar-heated sand drying bed compared with regular beds. The study was conducted at the Alexandria Eastern Sewage Treatment Plant. Climatic conditions were generally favorable for dewatering sludge on sand drying beds except when there was heavy rainfall during the wet season, which prolonged the drying time. The solar air heated drying beds saved about 35% of the bed area compared to conventional sand drying beds, and the drying time was cut from 18 days to 8 days. The solar air heated beds were less expensive than conventional open sand beds. The bed loading was about 147 kg solids/sq m/yr on average for conventional open sand beds compared to 248 kg solids/sq m/yr for solar air heated sand beds. It is recommended that conditioning with chemicals (e.g., lime) should be carried out only to increase the wet season bed loading if this is necessary. No advantage was gained from sludge conditioning during the dry season. Also, addition of lime resulted in the precipitation of heavy metals, thus increasing their concentration in the sludge. However, lime treatment reduced parasite concentrations, although this could be accomplished by 60 days of composting as well. (Rochester-PTT)
W91-08143

MESOPHILIC AND THERMOPHILIC DIGESTION OF MUNICIPAL SLUDGE IN A DEEP-SHAFT U-SHAPED BIOREACTOR.
Asian Inst. of Tech., Bangkok (Thailand). Div. of Environmental Engineering.
F. T. Tran, and R. D. Tyagi.
Water Science and Technology WSTED4, Vol. 22, No. 12, p 205-215, 1990. 1 fig, 12 tab, 19 ref.

Descriptors: *Aerobic digestion, *Biological wastewater treatment, *Municipal wastewater, *Oxygen, *Sludge digestion, Design criteria, Performance evaluation, Suspended solids, Temperature, Wastewater reactors, Wastewater treatment.

High oxygen-transfer rates frequently are required for economy in aerobic sludge digestion. To achieve high oxygen-transfer rates, the design of fermentation equipment favors maximizing the rate of oxygen transfer for cell growth, while minimizing the power requirement. One of the most promising contactors designed for high mass-transfer rates with lower power consumption is the airlift tower. Aerobic digestion of primary and secondary sludges was studied in airlift bioreactors at mesophilic and thermophilic temperatures. The experimental studies were conducted with a laboratory U-shaped airlift reactor with an operating volume of 23 L and a pilot U-shaped airlift reactor with an operating volume of 1150 L. In the laboratory reactor, at a lower temperature (6 C) and with a concentrated feed (3-4% solids) consisting of primary and secondary municipal sludge, a 30% volatile suspended solids (VSS) reduction was achieved with a hydraulic retention time of 2.5 days. The VSS loading rate of 8.2 kg VSS per cu m per day was achieved. This loading is comparable to that obtained in a pure-oxygen sparged mixed reactor. In the pilot plant reactor at mesophilic temperatures (31-33 C), a VSS loading rate of 7.9 kg VSS per cu m/day and a VSS reduction of 33% were achieved with a hydraulic retention time of four days. The high volatile loading rate and the higher percent VSS reduction capability of the airlift biodigester minimize the reactor volume requirements and the high oxygen transfer efficiency minimizes the aeration energy costs. These factors make the airlift autothermal biodigester an extremely efficient system with specific advantages in the digestion of high solids content sludges. (Rochester-PTT)
W91-08144

OXYGEN UTILIZATION RATE AS A CONTROL PARAMETER FOR THE AEROBIC STAGE IN DUAL DIGESTION.
Cape Town Univ. (South Africa). Dept. of Civil Engineering.
J. R. Messenger, H. A. de Villiers, and G. A. Ekama.
Water Science and Technology WSTED4, Vol. 22, No. 12, p 217-227, 1990. 4 fig, 3 tab, 22 ref.

Descriptors: *Aerobic digestion, *Biological wastewater treatment, *Oxygen uptake, *Sludge digestion, *Wastewater treatment, Carbon dioxide, Chemical oxygen demand, Heat generation, Oxygen, Oxygen utilization ratio, Performance evaluation, South Africa.

The dual digestion system treats sewage sludge in two sequential stages: (1) an autothermal thermophilic aerobic stage and (2) a mesophilic aerobic stage. Both stages are used separately in sludge treatment systems, but it has been claimed that the combination offers greater sludge treatment efficacy than either stage alone. A full-scale investigation of dual digestion was instituted at the Potsdam Wastewater Treatment Works (South Africa) to evaluate the claims for dual digestion. An 18-month study of the performance of the autothermal thermophilic aerobic stage (45 cu m) of a full-scale dual digestion plant, operated with pure oxygen, demonstrated that: (1) volatile solids and/or COD removal are poor parameters for estimating biological heat generation; (2) the biological heat generation is proportional to oxygen utilized at 13.0 MJ/kg O, a value which conforms closely to that obtained from bioenergetics and thermodynamics; (3) the maximum biological heat generation rate was limited by the maximum oxygen

utilization rate (OURbio) of the sludge; (4) because the aerobic reactor is oxygen-limited, the temperature could be completely and instantaneously controlled by the oxygen feed rate up to OURbio; and (5) CO2 generation in the vent gas was 0.68 mole CO2/mole O2 used instead of 1.0 as usually assumed. (Rochester-PTT)
W91-08145

STUDIES ON MICROBIAL LEACHING OF HEAVY METALS FROM MUNICIPAL SLUDGE.
Quebec Univ., Montreal. Centre de Recherche en Sciences de l'Environnement.
R. D. Tyagi, D. Couillard, and F. T. Tran.
Water Science and Technology WSTED4, Vol. 22, No. 12, p 229-238, 1990. 2 fig, 5 tab, 13 ref.

Descriptors: *Biological wastewater treatment, *Heavy metals, *Metals removal, *Microbial degradation, *Sludge management, *Sludge treatment, Centrifugation, Filtration, Leaching, Microorganisms, Municipal sludge, Nutrients, Odors.

Wastewater treatment plants generate a large amount of sludge having high concentrations of toxic heavy metals. The reduction of heavy metals in municipal sludge can be achieved by chemical methods, but these methods are associated with problems such as cost, operational difficulties, and large acid and lime requirements. A comparative study between continuous stirred tank reactor (CSTR) with cell recycle and air-lift reactor was carried out in 30-L capacity reactors for metal solubilization from anaerobically digested sludge. In CSTR at a residence time of 0.75 day, supplementing the feed sludge with 4 g/L of FeSO4.7H20, using 20% sludge recycle and adjusting the pH of the feed sludge to 4.5, resulted in the following metal solubilization: 91% Cu, 94% Zn, 93% Mn, 67% Cd, 67% Ni, 8% Cr, and 7% Pb. At 0.75 day retention time metals were solubilized to the recommended level in CSTR as well as in the air-lift reactor. The treated sludge is easy to filter in plates, filter press, centrifuge, or vacuum filter. The sludge nutrients do not seem to be diminished as a result of treatment and separation of solid-liquid. The ammonia-N fraction seems to be transformed to organic N. The decontaminated sludge has less odor. (Author's abstract)
W91-08146

COMPACTION-GRANULATION PROCESS TURNS MUNICIPAL SLUDGE INTO A VALUABLE FERTILIZER COMPONENT.
Brown and Caldwell, Atlanta, GA.
P. Wolstenholme.
Water Science and Technology WSTED4, Vol. 22, No. 12, p 239-247, 1990. 5 fig, 2 tab, 5 ref.

Descriptors: *Fertilizers, *Sludge disposal, *Sludge management, *Sludge utilization, *Wastewater treatment, Compaction, Grants, Granulation, Marketing, Pellets, Sludge drying.

To prepare dried municipal sludge material for use by the fertilizer industry, the Ocean County Utilities Authority, New Jersey, needed a process to increase the size of their sludge particles to between 1 and 3 mm. Several processes ('wet' agglomeration, pressure agglomeration, pelleting technology, and roll presses) were evaluated during the planning and design phases of the project. The most cost-effective and reliable process was pressure agglomeration by compaction with a roll press, followed by granulation and screening of the compacted material. This process was tested with a sample of the Authority's digested sludge that had been dried in a laboratory-scaled evaporator. Full-scale compaction and granulation test equipment was employed to confirm the feasibility of the process and to develop data for the design of the project. The product will be marketed through a fertilizer broker to the bulk-blending commercial fertilizer industry. The sludge process will be mixed with granulated inorganic fertilizer components, such as ammonium phosphates and potash, to raise the NPK percentages to commercial grade. This 'innovative' approach to sludge processing qualified the project for $60 million in special funding from the United States Environmental Protection Agency. (Author's abstract)
W91-08147

CONTROL OF HEAVY METALS AND ORGANOCHLORINES USING THE OIL FROM SLUDGE PROCESS.
Enersludge (Australasia) Pty Ltd., Suite 93 Havelock Mall, West Perth, WA 6005, Australia.
T. R. Bridle, I. Hammerton, and C. K. Hertle.
Water Science and Technology WSTED4, Vol. 22, No. 12, p 249-258, 1990. 7 tab, 9 ref.

Descriptors: *Chlorinated hydrocarbons, *Oil from sludge technology, *Sludge management, *Sludge treatment, *Waste recovery, Australia, Heavy metals, Incineration, Oil recovery, Performance evaluation, Pilot plants, Wastewater treatment.

The Oil from Sludge (OFS) technology, a low-temperature atmospheric pressure conversion process, has been demonstrated successfully at a 1 ton/day pilot scale. A 4-month pilot plant program to evaluate all unit operations comprising an integrated OFS plant has been successfully completed in for the Sydney Water Board. The unit operations of sludge dewatering, drying, and conversion to oil in the patented OFS reactor system were set up at the Malabar Sewage Treatment Plant in Sydney, Australia. Pilot testing of the char combustor was conducted off-site. Extensive heavy metal and organochlorine monitoring across each unit operation was conducted. The was no loss of contaminants across the dewatering and drying operations. With the exception of As and Hg, all heavy metals fed to the OFS reactor are retained in the char. Greater than 75% of polychlorinated biphenyls (PBCs) and 85% of hexachlorobenzene (HCB) present in the sludge are destroyed in the OFS reactor. Greater than 99.7% of the heavy metals fed to the fluidized bed combustor (FBC) are retained in the ash, except for Hg, of which 3% was found in the flue gas. The FBC ash was classified as non-hazardous according to the Toxic Characteristic Leaching Procedure. No organochlorines were detected in the dryer or FBC off-gases. The OFS technology offers decoupling of heavy metal and organochlorine control mechanism, thus allowing each to be controlled optimally. (Author's abstract)
W91-08148

COMMERCIALIZATION OF PRESSURIZED ELECTROOSMOTIC DEHYDRATOR (PED).
Shinko Pantec Co. Ltd., Kobe (Japan). Environmental Systems Div.
S. Kondoh, and M. Hiraoka.
Water Science and Technology WSTED4, Vol. 22, No. 12, p 259-268, 1990. 10 fig, 5 tab, 5 ref.

Descriptors: *Electro-osmosis, *Feasibility studies, *Filtration, *Sludge drying, *Sludge management, Dewatering, Electrodes, Performance evaluation, Pressurized electroosmotic dehydrator, Scanning electron microscopy, Waste management, Wastewater treatment.

Initial studies of application of the electroosmotic process to dewatering have failed to reach commercialization due to short life and leach-out of expensive electrodes, low filtration velocity, and high electric power consumption. A study was conducted to address these issues. Application of electroosmosis to conventional filter press dehydrators was studied with the aim of decreasing water content in sludge generated from wastewater treatment. Using a pressurized electroosmotic dehydrator (PED), it was possible to realize a reduction of water content in the biological excess activated sludge down to 50-60%. The new method has been commercialized by pre-concentration of the excess activated sludge, addition of electrolyte, and development of special carbon electrodes. Scanning electron microscopy demonstrated the suitability of the PED process for excess activated sludge by demonstrating that in the early stages of the PED process, dewatering by pressure and electrophoresis proceed simultaneously. Particles that normally cause clogging of the filter acquire a charge opposite that of the liquid in the capillary spaces of the sludge cake. The liquid is drawn smoothly through the filter cloth on the cathode, whereas most particles remain behind and few deposit on the cathode. (Rochester-PTT)
W91-08149

IMPROVED EFFICIENCY OF SEWAGE SLUDGE INCINERATION BY PRECEDING SLUDGE DRYING.
Wupperverband, Wuppertal (Germany, F.R.).
For primary bibliographic entry see Field 5E.
W91-08150

SOLIDIFICATION OF ELECTROPLATING WASTEWATER TREATMENT SLUDGES WITH CEMENT.
Sao Paulo Univ. (Brazil). Escola Politecnica.
J. R. Claudio, and P. A. Sobrinho.
Water Science and Technology WSTED4, Vol. 22, No. 12, p 287-301, 1990.1 fig, 7 tab, 13 ref.

Descriptors: *Brazil, *Industrial wastewater, *Metal-finishing wastes, *Sludge disposal, *Sludge management, *Waste solidification, Cementation, Heavy metals, Leaching, Sao Paulo.

In the Sao Paulo (Brazil) metropolitan area, the sludge resulting from the treatment of electroplating industry wastewater is disposed of inadequately, generating environmental hazards. One possible way to solve this problem would cementation of the sludge prior to disposal. Laboratory tests on cementation of sludge from electroplating industry wastewater were conducted with three types of cement produced in Brazil: CPC, Portland cement; POZ, pozzolanic cement; and CAF, blast furnace cement. Among the investigations conducted were: characterization of the sludge; preparation of sludge-cement mixtures in water/cement ratios of 0.3, 0.5, and 0.7, and study of their properties; measurements of mixture consistency using soil mechanics equipment; determination of leaching characteristics and resistance to compression of solidified specimens at ages of 7 days, 28 days, and 90 days; analysis of the sludge-cement mixtures; tests of solubility in water at the age of 90 days; and analysis of cyanide and heavy metals in the cure water. Solidification with cement appeared to be and efficient technology for the fixation of toxic metal ions such as Cd, Hg, and Pb and other metals such as Cr, Ni, Cu, or Zn present in large concentrations in electroplating wastewater treatment sludges. With the single exception Al(3+), the metallic ions determined in the leachate showed concentrations below drinking water standards. Mechanical resistance at 90 days of sludge-cement mixtures was similar to that of structural concrete. (Author's abstract)
W91-08152

IMPROVED CENTRIFUGE SLUDGE DEWATERING BY AUTOMATIC BACKDRIVE TORQUE CONTROL.
Metropolitan Water Reclamation District of Greater Chicago, Cicero, IL. Stickney Water Reclamation Plant.
B. A. Garelli, E. L. Kokat, and B. J. Schwartz.
Water Science and Technology WSTED4, Vol. 22, No. 12, p 303-308, 1990. 3 fig, 4 tab, 2 append.

Descriptors: *Centrifuges, *Control systems, *Illinois, *Sludge drying, *Wastewater treatment, Automation, Backdrives, Cost analysis, Process control, Sludge cake, Torque control.

The Stickney Water Reclamation Plant (Cicero, Illinois) treats approximately 800 million gallons per day, with a design capacity rated at 1.475 billion gallons per day (about 5.6 million cu m/day). The plant, which is a conventional waste activated sludge plant processing annually approximately 65,000 dry tons of digested solids through its dewatering centrifuges, has a service area of 260 square miles. An investigation was conducted of different automatic torque control systems for performance optimization of solid bowl centrifuges at this plant. Two automatic hydraulic backdrives and a direct current automatic torque controlled backdrive were tested on centrifuges that dewater

digested sludge conditioned with a polymer and a combination of polymer and ferric chloride. The centrifuge unit of advanced design coupled with the direct current automatic torque controlled backdrive produced a cake having a solids content of 30% and a solids capture of 97%. The regular production unit produced a cake having a solids content of 15% and a solids capture of 85%. It seems apparent, after 4 mo of testing and 1500 sample analyses, that automatic torque control will be an integral part of centrifugation in the future. Thirty-percent cakes and recoveries of 95% or more should become the norm in the next decade. For the Metropolitan Water Reclamation District of Greater Chicago, this would translate into savings of $45 per dry ton of solids. (Rochester-PTT)
W91-08153

SUSTAINED SHOCKWAVE PLASMA (SSP) DESTRUCTION OF SEWAGE SLUDGE: A RAPID OXIDATION PROCESS.
Neutrail Corp., Concord, MA.
M. M. Mathiesen.
Water Science and Technology WSTED4, Vol. 22, No. 12, p 339-344, 1990. 1 tab.

Descriptors: *Oxidation, *Sludge treatment, *Sustained shockwave plasma, *Wastewater treatment, Air pollution prevention, Cost analysis, Incineration, Performance evaluation, Physical wastewater treatment, Sludge drying.

The ideal sludge processing method should destroy sludge where it is produced, at the rate it is produced, and should leave behind clean air and a non-hazardous, usable residue. The Neutrail SSP process consists of three main steps: drying, oxidation, and gas cleaning. The process is designed to destroy completely all organic structures, limit acid gas formation, and retain a maximum amount of all volatile heavy metals in the solid residue in a non-leachable form, thereby making it possible to devise a gas cleaning system that can deliver a clean off-gas economically. Sewage sludge is destroyed and neutralized in an environmentally safe way by rapid, plasma-assisted oxidation. The material is rendered inert where it is produced, leaving behind a benign and useful solid oxidation byproduct and producing a clean off-gas. The solid product can be used as a cement or aggregate. The process is based on oxidation enhanced by employment of sustained shockwave plasma (SSP) and controlled oxidation. The process is very compact because of rapid throughput and near-stoichiometric air requirements. It is entirely enclosed. The fuel is derived from the sludge itself with a small amount of added electrical power. From an economic standpoint, the process offers savings over known incineration processes and provides greater environmental safety, both from the point of view of gaseous emissions and solid byproducts. The process can be operated economically from a level of 20 dry tons per 24 hr and up. (Rochester-PTT)
W91-08157

BIOLOGICAL NITRIFICATION/DENITRIFICATION OF HIGH SODIUM NITRITE (NAVY SHIPYARD) WASTEWATER.
Montgomery (James M.), Inc., Pasadena, CA.
S. Kamath, D. A. Sabatini, and L. W. Canter.
Environmental Pollution ENPOEK, Vol. 69, No. 1, p 25-38, 1991. 5 fig, 4 tab, 16 ref.

Descriptors: *Biological wastewater treatment, *Chemical wastewater, *Denitrification, *Industrial wastewater, *Military reservations, *Nitric acid, *Nitrification, *Wastewater treatment, Heavy metals, Microorganisms, Nitrogen removal, Shipyard wastes, Sludge, Wastewater reactors.

In the hydroblasting of ships' boiler tubes, a wastewater high in nitrite (as high as 1200 mg/L) is produced by the US Navy. Research evaluated the use of a suspended-growth biological system to treat this wastewater by denitrification. Two biological treatment configurations were evaluated (direct denitrification versus nitrification/denitrification) with nitrification/denitrification producing better nitrite removal efficiencies (54 to 62% versus 40%, respectively). The introduction of metals (cadmium, chromium, lead, copper and iron) in concentrations typical for this wastewater did not inhibit nitrite removal efficiencies. The influent metal concentrations ranged from 0.02 mg/L for cadmium to 22 mg/L for iron and the metal removal efficiencies ranged from 4.8% for cadmium to 50% for copper. Increasing sludge age resulted in improved nitrite removal efficiencies (52%, 57% and 74% for sludge ages of 4, 6, and 8 days, respectively). The resulting biokinetic constants were similar to those reported by others for lower influent concentrations of nitrite or nitrate. (Author's abstract)
W91-08171

BIOLOGICAL TREATMENT OF WASTEWATER BY SELECTED AQUATIC PLANTS.
Banaras Hindu Univ., Varanasi (India). Pollution Research Lab.
B. D. Tripathi, and S. C. Shukla.
Environmental Pollution ENPOEK, Vol. 69, No. 1, p 69-78, 1991. 1 fig, 1 tab, 31 ref.

Descriptors: *Biological wastewater treatment, *Chlamydomonas, *Chlorella, *Chlorophyta, *Microcystis, *Scenedesmus, *Wastewater treatment, *Water hyacinth, Algae, Coliforms, Dissolved oxygen, India, Macrophytes, Municipal wastewater, Nitrates, Oxygen demand, Phosphates, Suspended solids.

Pollutant-removal efficiency of certain macrophytes and algae, such as Eichhornia crassipes, Microcystis aeruginosa, Scenedesmus falcatus, Chlorella vulgaris and Chlamydomonas mirabilis, has been tested under laboratory conditions to evaluate their potential role in wastewater treatment. Sewage of the city of Varanasi (India), mixed with the effluents of about 1200 small-scale industries, was used for the tests. The investigation was performed in three stages, i.e., a water hyacinth culture followed by an algal culture, and finally a second water hyacinth culture. For the first water hyacinth culture, 10 water hyacinth plants were grown in a tank of wastewater with 15 days' retention time. In the second stage, algal species were cultured in the treated wastewater for 5 days, while in the third stage, water hyacinth plants were again grown for further treatment in the wastewater for 9 days. This three-stage aquaculture resulted in very high reductions of biochemical oxygen demand (BOD; 96.9%), suspended solids (78.1%), total alkalinity (74.6%), PO4-P (89.2%, NO3-N (81.7%), acidity (73.3%), NH4-N (95.1%), chemical oxygen demand (COD: 77.9%) hardness (68.6%) and coliform bacteria (99.2%). An increase in the concentration of dissolved oxygen (70%) was also observed. This three-stage system of wastewater treatment is an inexpensive and convenient method of sewage treatment which can be adopted throughout warmer and temperate climates. (Author's abstract)
W91-08174

TOXICITY REDUCTION IN INDUSTRIAL EFFLUENTS.
For primary bibliographic entry see Field 5G.
W91-08192

SOURCE IDENTIFICATION, TESTING, AND TREATMENT.
Eckenfelder, Inc., Nashville, TN.
For primary bibliographic entry see Field 5B.
W91-08195

REMOVAL OF METALS TO NONTOXIC LEVELS.
Eckenfelder, Inc., Nashville, TN.
P. W. Lankford.
IN: Toxicity Reduction in Industrial Effluents. Van Nostrand Reinhold, New York. 1990. p 98-124, 8 fig, 17 tab, 10 ref.

Descriptors: *Industrial wastewater, *Metals, *Regulations, *Standards, *Wastewater treatment, Adsorption, Arsenic, Barium, Best available technology, Cadmium, Chemical precipitation, Chemical treatment, Chromium, Heavy metals, Ion exchange, Lead, Maximum contaminant level, Mercury, Reverse osmosis, Selenium, Silver, Water quality.

Heavy metals are found in a variety of industrial wastewater. It is sometimes quite important to reduce the levels of metals prior to biological treatment to avoid toxicity or accumulation of metals on the biological mass. It is also important to reduce metal levels to comply with best available technology (BAT) discharge permits and avoid aquatic toxicity of the effluent. There are still other conditions where drinking water maximum contaminant levels (MCLs) must be considered. Metals removal is most typically achieved through source treatment, chemical precipitation, or incidental removal in biological or adsorption processes. The freshwater and marine chronic criteria for the various metals vary from 0.012 to 1,000 microgm/L and 0.025 to 560 microgm/L, respectively, each four orders of magnitude. Since the chronic criteria are generally the most stringent and of greatest long-term concern, this chapter focuses on chronic and not acute levels. The US EPA has established MCLs for numerous organic compounds and metals in drinking water. Although these are not directly applicable treatment standards, they do occasionally arise as a consideration in treatment programs. These values are: As (50 microgm/L); Ba (1,000 microgm/L); Cd (10 microgm/L); Cr (50 microgm/L); Pb (50 microgm/L); Hg (2 microgm/L); Se (10 microgm/L); and silver (50 microgm/L). BAT levels vary from 3 to 10,000 microgm/L, four orders of magnitude and are typically not adequate to treat effluents to below toxic levels without consideration of instream dilution. Only through treatment in more concentrated source streams followed by dilution in the total stream can the water quality levels be met using the described technology. This treatment can be achieved through: chemical precipitation and coprecipitation; adsorption; ion exchange; or reverse osmosis. (See also W91-08191) (Lantz-PTT)
W91-08196

AEROBIC BIOLOGICAL TREATMENT.
Eckenfelder, Inc., Nashville, TN.
W. W. Eckenfelder.
IN: Toxicity Reduction in Industrial Effluents. Van Nostrand Reinhold, New York. 1990. p 125-145, 10 fig, 4 tab, 12 ref.

Descriptors: *Aerobic treatment, *Biodegradation, *Biological treatment, *Wastewater treatment, Activated carbon, Aeration, Air stripping, Biochemical oxygen demand, Biological wastewater treatment, Biomass, Organic compounds, Oxidation, Sorption, Volatile organic compounds.

A majority of the priority or toxic organics can be removed using biological treatment. Their actual removal, however, may occur through one or more mechanisms--sorption, stripping, or biodegradation. Limited sorption on biological solids occurs for a variety of organics, but this phenomenon is not a primary mechanism of organic removal in the majority of cases. Volatile organic compounds (VOCs) will air-strip in such biological treatment processes as trickling filters, activated sludge, and aerated lagoons. Depending on the VOC in question, both air stripping and biodegradation may occur. The stripping of VOCs in biological treatment processes is currently receiving considerable attention in the United States since current legislation severely limits permissible emissions of VOCs. Most of the priority or toxic organics will biodegrade, even though some degrade very slowly. In addition, the biomass must be acclimated to the specific organic, particularly when a dissimilar biomass such as a municipal biological sludge is initially used to treat the wastewater. Initial acclimation may take as much as several weeks, however, acclimated biomass possesses a genetic memory. When adequate acclimation and a suitable cosubstrate are provided, there are conditions under which extremely low levels of priority organics can be attained biologically. For example, phenolics have been treated in the activated sludge process to effluent levels of < 10 microgm/L. Soluble microbial products (SMP) are generated both through the degradation of

organics and through the endogenous degradation of the biomass. The SMP are oxidation byproducts which are largely nondegradable in the activated sludge process. Many of these byproducts are high molecular weight and have a high toxicity to some aquatic species. Aerobic biological processes such as the activated sludge process are not applicable to wastewaters containing biochemical oxygen demand (BOD) levels < 50 mg/L since microbial growth is insufficient to prevent washout. Bio-oxidation of low levels of specific organics can best be achieved in a biologically active carbon column in which the carbon serves as the media for biofilm growth: 2-3 mg/L of organic compounds can be treated without supplemental aeration when the influent wastewater is near saturation. (See also W91-08191) (Lantz-PTT)
W91-08197

ANAEROBIC BIOLOGICAL TREATMENT.
Vanderbilt Univ., Nashville, TN.
R. E. Speece.
IN: Toxicity Reduction in Industrial Effluents. Van Nostrand Reinhold, New York. 1990. p 146-171, 14 fig, 7 tab, 24 ref.

Descriptors: *Anaerobic digestion, *Biological wastewater treatment, *Industrial wastewater, *Wastewater treatment, Acclimatization, Aromatic compounds, Chlorinated aromatic compounds, Hydrocarbons, Organic compounds, Phenols, Phthalates, Toxicity.

The Enso-Fenox process has been very successfully used to remove chlorinated phenolic compounds from pulp bleaching effluents. It is a two-stage anaerobic/aerobic process consisting of a nonmethanogenic anaerobic fluidized bed followed by a trickling filter. Overall reduction of chlorophenols is 65-100%. Studies have been conducted on reductive dechlorination of chlorinated aromatic compounds under anaerobic conditions with chlorinated phenols as the sole carbon and energy source. Approximately 40% of the added chlorophenols was converted to CH4 and CO2. Substrate loading rates were 20 mg/L/d at hydraulic detention times of 2-4 days with 90% substrate conversion efficiency. Reductive dechlorination of mono-, di-, tri-, and pentachlorophenols has been demonstrated in anaerobic sewage sludge. The following constituents were tested in the laboratory at their approximate concentrations in coal conversion wastewater (CCWW) and were anaerobically degraded in serum bottles: 1,000 mg/L phenol; 500 mg/L resorcinol; 1,000 mg/L benzoic acid; 500 mg/L p-cresol; 200 mg/L pyridine; 2,000 mg/L benzoic acid; 250 mg/L 4-methylcatechol; 500 mg/L 4-ethylpyridine; and 2,000 mg/L hexanoic acid. The findings from this study confirm those of other researchers--the aforementioned compounds all degrade anaerobically with gas production. A petrochemical may initially exhibit toxicity to an unacclimated population of methane-fermenting bacteria, but with acclimation the toxicity may be greatly reduced or disappear. In addition, the microorganisms may develop the capacity to actually degrade compounds which showed initial toxicity. There is no conclusive correlation between the toxicity characteristics of an organic compound to an unacclimated acetate-enriched methanogenic culture and the eventual metabolism of that same organic by the acclimated culture. Since biomass digestion requires a complete consortium of bacteria, it is relevant to study the effect of a given toxicant and its potential acclimation on the overall process as well as to individual steps within the process. A toxicant can inhibit the rate-limiting step and/or change the step that is rate-limiting. Both manifestations of toxicity can severely affect the overall process. (See also W91-08191) (Lantz-PTT)
W91-08198

STRIPPING OF VOLATILE ORGANICS.
Centre for Research in Environmental and Water Resources Engineering, Haifa (Israel).
Y. Argaman.
IN: Toxicity Reduction in Industrial Effluents. Van Nostrand Reinhold, New York. 1990. p 172-202, 7 fig, 8 tab, 8 ref.

Descriptors: *Air stripping, *Steam stripping, *Volatile organic compounds, *Wastewater treatment, Activated sludge, Aeration, Biodegradation, Henrys Law, Organic compounds, Sludge treatment, Waste recovery.

Air stripping is one of several processes available that removes volatile organic compounds (VOCs) from aqueous streams. Air stripping processes employ gas-liquid contacting systems that enhance the transfer of VOCs from the liquid phase to the gas phase. Various types of aeration devices have been designed to optimize transfer, and they fall into two general categories: (1) injection of water into air, and (2) injection of air into water. In both systems, mechanical energy creates air-water interfaces across which transfer of the contaminant can occur. Examples of water-into-air systems are spray systems into the open air, spray towers, and tray and packed towers. Air-into-water systems typically use diffused aeration. VOCs will air strip in activated sludge plants due to the high air volumes which come in contact with the aerated wastes. Depending on the VOC in question, both air stripping and biodegradation may occur. The fraction of VOCs which will be stripped will depend upon several factors, namely the Henry's Law constant, the biodegradability, the power level in the aeration basin, and in some cases the initial concentration of VOCs. The concentration of nonvolatile organics will affect the composition of the sludge and hence the fraction biodegraded and stripped. In wastewater treatment, steam stripping is normally used to separate and recover VOCs from concentrated waste streams. It is usually considered a pretreatment process to be followed by some other conventional process for effluent polishing. Preheated raw wastewater is introduced at the top of the stripping tower and flows downward, countercurrent to the rising vapors. The overhead vapor is condensed and passed into a decanter where the recovered organics are separated from the aqueous phase. The stripped waste exits at the bottom of the tower. Reflux of the decanted condensate may or may not be practiced depending on the desired composition of the overhead stream. (See also W91-08191) (Lantz-PTT)
W91-08199

GRANULAR CARBON ADSORPTION OF TOXICS.
Eckenfelder, Inc., Nashville, TN.
W. W. Eckenfelder.
IN: Toxicity Reduction in Industrial Effluents. Van Nostrand Reinhold, New York. 1990. p 203-228, 12 fig, 4 tab, 5 ref.

Descriptors: *Activated carbon, *Adsorption, *Granular activated carbon, *Wastewater treatment, Chemical reactions, Chemical treatment, Diffusion, Equilibrium, Particle size, Physical treatment, Porosity.

In many cases, organics responsible for toxicity are either nonbiodegradable or refractory byproducts. These materials can frequently be removed by adsorption on an active-solid surface. The most commonly used adsorbent is activated carbon. There are essentially three consecutive steps in adsorption: film diffusion, pore diffusion, and adsorptive reaction. The adsorbate passes through the surface film to the adsorbent surface (film diffusion). The adsorbate then passes through the adsorbent pores (pore diffusion). Last, the adsorbate binds to the adsorbent surface (adsorptive reaction). In continuous flow carbon columns, film diffusion or pore diffusion may be the rate limiting step of adsorption. Activated carbons are made from a variety of materials including wood, lignin, bituminous coal, lignite, and petroleum residues. Granular carbons produced from medium volatile bituminous coal or lignite have been most widely applied to the treatment of wastewater. Activated carbons have specific properties depending on the material source and the mode of activation. In general, granular carbons from bituminous coal have a small pore size, a large surface area, and the highest bulk density as compared to lignite carbon. In order to evaluate the feasibility and economics of adsorption, a laboratory adsorption study should be conducted. If granular carbon is to be evaluated, the carbon must first be ground to pass a 325-mesh screen. Grinding the carbon will not significantly affect its adsorptive capacity, but will increase the rate of adsorption. The carbon column can be considered as a nonsteady-state process in which, as an increasing quantity of water is passed through the bed, the adsorbent is removed in an increasing amount. A breakthrough point is reached when the volume of water which can be passed through the bed before maximum effluent concentration is reached. As the adsorption zone falls to the bottom of the bed, the effluent concentration increases until it equals the influent concentration. In granular carbon columns, the carbon capacity at breakthrough, as related to exhaustion, is a function of the waste complexity. A single organic will yield a sharp breakthrough curve such that the column is > 90% exhausted when breakthrough occurs. (See also W91-08191) (Lantz-PTT)
W91-08200

POWDERED ACTIVATED CARBON TREATMENT (PACT).
Eckenfelder, Inc., Nashville, TN.
P. W. Lankford.
IN: Toxicity Reduction in Industrial Effluents. Van Nostrand Reinhold, New York. 1990. p 229-246, 11 fig, 5 tab, 12 ref.

Descriptors: *Activated sludge process, *Powdered activated carbon, *Wastewater treatment, Adsorption, Aeration, Biological wastewater treatment, Color removal, Effluents, Filter regeneration, Heavy metals, Industrial wastewater, Mixed liquor solids, Nitrification, Organic compounds, Physical treatment, Volatile organic compounds.

PACT is the application of powdered activated carbon (PAC) to the activated sludge process. Activated carbon is mixed with the influent wastewater or fed directly to the aeration basin. The carbon-biosludge mixture is settled and the sludge recycled in the same manner as in the conventional activated sludge process. The waste activated sludge similarly contains the carbon and biosludge mixture. The total mixed liquor suspended solids (MLSS) in a PAC aeration basin will normally be roughly half biological and half carbon, the exact ratio depending on the nature of the substrate (or adsorbate), the biochemical synthesis coefficient, and the biological sludge age. Moreover, carbon adsorptive capacities are influenced by: the characteristics of the carbon used; the nature of the adsorbate; the degree of biological regeneration; and, the influent concentration of the organic substrate. Because of the many variables involved in the carbon and biomass components of the total MLSS, it is realistic to compute the sludge age in terms of the total mass only. However, PAC lends itself to a completely mixed contactor where the carbon is at equilibrium with the effluent concentration. In numerous side-by-side comparisons of PACT with a single GAC column, the carbon requirement to achieve the same effluent organic concentration has been determined to be approximately the same for both options. Addition of PAC to the activated sludge system may reduce the inhibitory effects, at least partially, or some components of the wastewater, and consequently promote nitrification. Although not typically utilized as a standard process for the removal of metal contaminants from wastewater, carbon adsorption does at times provide excellent incidental treatment. PAC has been heavily relied upon for color removal in water treatment for many years. PACT is an excellent configuration in which to accomplish color removal from wastewaters. The addition of PAC to activated sludge not only results in improved removals of such contaminants as TOC and NH3, through improved biodegradation, and metals and color through adsorption, but it also reduces the losses of some volatile organics to the air phase. PAC is most effectively regenerated by wet air regeneration. (See also W91-08191) (Lantz-PTT)
W91-08201

CHEMICAL OXIDATION OF TOXIC, INHIBITORY, AND REFRACTORY ORGANICS.

Vanderbilt Univ., Nashville, TN.
A. R. Bowers.
IN: Toxicity Reduction in Industrial Effluents. Van Nostrand Reinhold, New York. 1990. p 247-272, 6 fig, 6 tab, 39 ref.

Descriptors: *Chemical treatment, *Organic compounds, *Oxidation, *Toxicity, *Wastewater treatment, Catalysis, Chemical reactions, Chlorine, Chlorine dioxide, Hydrogen ion concentration, Hydrogen peroxide, Ozone, Potassium permanganate, Temperature.

Chemical oxidation for treatment of organic compounds has traditionally been considered uneconomical compared to biological treatment processes. However, many organic compounds are toxic, inhibitory, or refractory to microorganisms; and additionally, particular organic compounds may result in the production of soluble microbial products that produce effluent aquatic toxicity in violation of discharge permits. These difficulties have resulted in new regulations for pretreatment of toxic organics prior to discharge into publicly owned treatment works (POTWs). Therefore, chemical oxidation is being considered as a pretreatment alternative for toxic organics, prior to discharge into the biological treatment system or POTW, and in certain instances, as a complete treatment process to meet effluent guidelines for BOD/COD reduction and toxicity. A variety of chemical oxidants has been used in water and wastewater treatment processes for disinfection and/or destruction of undesirable chemical species (organic or inorganic), and include: chlorine, chlorine dioxide, ozone, hydrogen peroxide, and potassium permanganate. The rates of oxidation reactions are perhaps the most important considerations in wastewater applications, and are dependent upon many variables which must be considered simultaneously. These include: temperature, concentration, catalysts, pH, reaction by-products, and system impurities. Preoxidation is mandatory when sufficient toxicity is present in the wastewater to retard biological growth and prevent sufficient treatment in a biological treatment process. A summary of the data collected while conducting case studies is given in tabular form, and indicate a dramatic reduction in toxicity in nearly all cases; in most instances, no detectable toxicity was observed after oxidation with H2O2. (See also W91-08191) (Lantz-PTT)
W91-08202

MANAGEMENT OF SLUDGES FROM TREATMENT OF TOXIC WASTEWATERS.
Eckenfelder, Inc., Nashville, TN.
J. L. Pintenich.
IN: Toxicity Reduction in Industrial Effluents. Van Nostrand Reinhold, New York. 1990. p 273-315, 15 fig, 13 tab, 10 ref.

Descriptors: *Sludge disposal, *Sludge treatment, *Waste disposal, *Waste treatment, *Wastewater treatment, Biological treatment, Chemical treatment, Hazardous wastes, Legislation, Physical treatment, Regulations, Solid wastes, Standards, Thermal properties.

Several of the unit operations utilized to reduce the aquatic toxicity of industrial effluents generate semi-solid residues or sludges. In some systems, the inherent toxicity of the effluent is concentrated almost totally in the sludge, such as heavy metals removed by precipitation. The sludge management strategy chosen in a specific application depends principally upon three interrelated factors: (1) the physical and chemical characteristics of the sludge; (2) the susceptibility of the sludge to various treatment processes; and (3) the final disposal option for the sludge. Geographic and economic constraints can also be important. At both the federal and state levels, many restrictive regulations deal with the ultimate disposal of wastes. By definition, a solid waste is any discarded material, whether it be a solid, liquid, semi-solid, or contained gas. Solid wastes include municipal refuse, sludges, many industrial wastes, and other wastes that are not excluded by regulation or excluded by a variance to the regulations. Hazardous wastes are those solid wastes which could cause or contribute to an increase in human mortality or serious illness, or could pose a hazard to human health or the environment when improperly managed. A variety of process wastewaters and wastewater treatment sludges are designated as listed hazardous wastes, and are elaborated in tables in this chapter. For the most part, these wastes contain one or more toxic hazardous constituents. The federal hazardous waste management regulations provide for control over all aspects of the management of wastes, from their point of generation to their ultimate disposal. For some sludges, the selection of the optimum treatment and disposal technologies is relatively straightforward. Usually, however, several combinations could be employed in a sludge management strategy. Experimental evaluations, regulatory considerations, and economic comparisons are needed to make final selections. Physical processes have as their goal the reduction of the volume and weight of the sludge through the removal of liquids. Biological processes are used to biochemically oxidize organic materials, while in thermal processes, the applied energy is used to dewater, destruct and/or detoxify the sludge. (See also W91-08191) (Lantz-PTT)
W91-08203

ECONOMICS OF TOXICITY REDUCTION.
Eckenfelder, Inc., Nashville, TN.
For primary bibliographic entry see Field 6C.
W91-08204

5E. Ultimate Disposal Of Wastes

HAZARDOUS AND INDUSTRIAL WASTES: PROCEEDINGS OF THE 21ST MID-ATLANTIC INDUSTRIAL WASTE CONFERENCE.
For primary bibliographic entry see Field 5D.
W91-07139

SOLIDIFICATION AND RE-USE OF STEEL INDUSTRY SLUDGE WASTE.
Lehigh Univ., Bethlehem, PA. Dept. of Civil Engineering.
S. Pamukcu, I. J. Dugelman, and J. D. Lynn.
IN: Hazardous and Industrial Wastes: Proceedings of the 21st Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1989. p 3-15. 2 fig, 2 tab, 10 ref.

Descriptors: *Industrial wastes, *Sludge utilization, *Steel industry, *Waste treatment, *Waste utilization, Construction materials, Sludge disposal, Waste disposal, Waste stabilization.

Effective utilization of waste material as an inexpensive alternative for conventional construction materials presents a viable solution to a number of material and waste problems if there are no adverse environmental effects and the material performs similarly or equally well as the one it replaces. One steel company developed a process that utilized lime and silica pozzolanic technology to solidify/stabilize liquid and solid wastes so that these can be disposed of as non-hazardous materials. The solidified/stabilized waste material can be used as a liner and/or cap for waste lagoons and landfills. The physical properties of a number of materials developed from steel industry sludge waste were examined both as-is and in combination with aggregate to form a semi-concrete material. Strength and permeability of various mixtures were studied to determine optimum property values without compromising economy. The steel industry's stabilization/solidification process appeared to produce highly stable materials out of steel waste. Laboratory studies indicated that due to improved physical properties of the material it can be used as a construction material. The basic material is currently being tested in a large scale field implementation for re-use as an interim cap on an existing waste lagoon. (See also W91-07139) (Mertz-PTT)
W91-07140

OPERATIONS AND MONITORING OF LAND TREATMENT OF BIODEGRADABLE PETROLEUM WASTE.
For primary bibliographic entry see Field 5D.
W91-07154

PROPERTIES AND USE OF FLY ASHES FOR EMBANKMENT.
Drexel Univ., Philadelphia, PA.
F. J. Biehl, J. P. Martin, J. Browning, and R. A. Collins.
IN: Hazardous and Industrial Wastes: Proceedings of the 21st Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1989. p 229-246. 8 fig, 2 tab, 12 ref.

Descriptors: *Fly ash, *Waste disposal, *Waste utilization, Coal wastes, Construction materials, Hazardous wastes, Industrial wastes, Powerplants, Waste stabilization.

Powerplants produce millions of tons of ash annually as byproducts, but only a fraction is productively employed in concrete, earthwork, and mineral wool manufacture. The balance must be disposed of in impoundments and landfills at great expense. Consequently, powerplants are making their ash available to other users to avoid the costs of disposal as a waste. Coalburning ash has a number of uses in civil engineering projects. Bottom ashes, often angular sand and gravel-sized particles, are routinely employed as light-weight aggregate in highway construction. Fly ash, the finer, silt-size fraction recovered from stack emission, is used in stabilized roadway bases, fill and impoundment liners, and waste stabilization. Technical, regulatory and public relations issues often arise with the re-use of any industrial waste. Fly ash is specifically exempted from classification as a hazardous waste and regulations in many states often exempt it from classification as a waste altogether if it is directly reused. In two separate investigations, the properties of six ashes from three powerplants in the Philadelphia-Wilmington-South Jersey area were studied. All ashes originated from burning bituminous coal from the Northern Appalachian area. The ashes behaved as frictional materials forming single grained particle structures. The low specific gravities, silt sizes, and spherical nature make fly ashes very susceptible to wind and water erosion, with water erosion being a concern both on the surface and in the subsurface. Soil cover is needed on embankments to prevent surficial erosion, and filter cloths and graded soil or bottom ash layers are needed to prevent piping into subsurface drains. Compaction curves of all the ashes tested were relatively flat, implying low sensitivity of the compacted density to the compaction moisture content. This is a major advantage over the plastic fine grained soils often used in structural fills. Low permeability indicates that seepage will move around a fly ash body if there is an alternate path of lower resistance. Fly ash is a granular, but poorly draining, fine-grained material. Moisture effects are much more pronounced for the lightweight compacted fly ashes. (See also W91-07139) (Mertz-PTT)
W91-07155

DESIGN AND CONSTRUCTION OF FULLY-DRAINED SYSTEMS FOR STORAGE OF MINERAL WASTES.
W. A. Cincilla, and D. R. East.
IN: Hazardous and Industrial Wastes: Proceedings of the 21st Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1989. p 247-258. 9 fig, 2 ref.

Descriptors: *Coal wastes, *Mine wastes, *Waste disposal, *Waste storage, Fly ash, Land disposal, Metals, Temperature effects, Waste management, Waste treatment, Wastewater treatment facilities.

Millions of tons of wastes are generated annually by the U.S. mineral industries, the greatest share of which is in the form of mill tailings from the processing of metallic ores and coal refuse. These waste products vary greatly, not only in their physical consistency but in their relative potential for environmental impact. Fifteen fully-drained facilities for the storage of mineral wastes were designed by Knight Peisold in North America over five years. The facilities are located in a wide range of climatic conditions from desert to Pacific-

coastal rain forest and altitudes of 11,000 feet. Although each site and set of operating constraints are unique, the basic design philosophy is the same--the efficient removal of process fluids and systematic rotational waste deposition. Laboratory testing indicates that the same principles which were successful in metallic ore waste disposal can be applied to other slurried waste products such as fly ash and phosphatic clay waste. Operation of facilities of this type under severe winter conditions has presented the most difficulty. However, modifications in depositional strategy and pond volume levels, as well as design modifications to sumps and return water lines, have been adequate in minimizing the adverse effects of cold temperatures. Another area that has been of particular concern is the selection of geotextiles for soil separation and permeability. Extensive in-house testing has isolated several groups of geotextiles that have excellent potential for continued application for very-fine-grained waste particles. In all cases, the fully-drained designs were more cost effective than conventional fully-saturated design. (See also W91-07139) (Mertz-PTT)
W91-07156

TRANSPORTABLE MODULAR INCINERATION: DIFFERENT MODES, DIFFERENT PURPOSES, DIFFERENT PERMIT REQUIREMENTS.
ENSCO Environmental Services, Inc., Fremont, CA.
D. Morell.
IN: Hazardous and Industrial Wastes: Proceedings of the 21st Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1989. p 259-266.

Descriptors: *Hazardous wastes, *Incineration, *Waste disposal, *Waste treatment, Economic aspects, Permits, Rehabilitation, Transportable incineration, Transportation.

Use of transportable modular incinerators for hazardous waste incineration is examined. Often, transportability may help solve tough problems of siting, permitting, community relations, and economic marketplace uncertainty. Ironically, however, the same technology has to acquire vastly different permitting approvals depending on its operation mode. This paradox has the potential to restrict use of these units to accomplish their designed objectives. Five different modes of operation have been identified in this typology of incinerator siting: onsite remediation; onsite remediation, plus treatment of continuing wastes; onsite remediation, plus treatment of remediation wastes from nearby small sites; offsite commercial incineration; and leap frog siting. Transportable units can operate in any one of these modes in a base load situation; be deployed elsewhere for a temporary period; and then return again to their original assignment. This mode allows the units to operate more economically, and indeed may be essential to long-term cost-effective ownership and operation of a transportable unit. (See also W91-07139) (Mertz-PTT)
W91-07157

SEEKING ORDER WITHIN THE CHAOS OF TOXICS LAWS: THE TOXICS PROGRAM MATRICES IN NEW JERSEY AND PENNSYLVANIA.
ENSCO Environmental Services, Inc., Fremont, CA.
For primary bibliographic entry see Field 5G.
W91-07169

COMPOSTING OF EXPLOSIVES AND PROPELLANT CONTAMINATED SEDIMENTS.
Weston (Roy F.), Inc., West Chester, PA.
For primary bibliographic entry see Field 5D.
W91-07180

DETERMINATION OF THE CHEMICAL SUITABILITY OF A DREDGED MATERIAL CONTAINMENT AREA FOR AQUACULTURE.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
For primary bibliographic entry see Field 5C.
W91-07213

HILLSLOPE EROSION AT THE MAXEY FLATS RADIOACTIVE WASTE DISPOSAL SITE, NORTHEASTERN KENTUCKY.
Geological Survey, Louisville, KY. Water Resources Div.
For primary bibliographic entry see Field 2J.
W91-07239

TRIAXIAL- AND UNIAXIAL-COMPRESSION TESTING METHODS DEVELOPED FOR EXTRACTION OF PORE WATER FROM UNSATURATED TUFF, YUCCA MOUNTAIN, NEVADA.
Colorado School of Mines, Golden. Dept. of Geology.
For primary bibliographic entry see Field 2G.
W91-07243

SCREENINGS AND GRIT IN SEWAGE: REMOVAL, TREATMENT AND DISPOSAL. PHASE 3: STORM WATER OVERFLOWS AND PUMPING STATIONS.
For primary bibliographic entry see Field 5D.
W91-07248

CALIBRATION OF GROUNDWATER MODELS FOR THE GRIMSEL UNDERGROUND ROCK LABORATORY, SWITZERLAND.
Colenco Ltd., Baden (Switzerland).
For primary bibliographic entry see Field 2F.
W91-07282

REDUCING GROUNDWATER FLOW MODEL UNCERTAINTIES AT YUCCA MOUNTAIN.
Weston (Roy F.), Inc., Washington, DC.
For primary bibliographic entry see Field 2F.
W91-07283

MODELLING HEAT TRANSFER NEAR A DEEP UNDERGROUND NUCLEAR WASTE REPOSITORY: A DISCUSSION OF BOUNDARY CONDITIONS.
Agence Nationale pour la Gestion des Dechets Radioactifs, Fontenay-aux-Roses (France).
J. M. Bodenes, L. Dewiere, P. Oustriere, J. Y. Ausseur, and A. Menjoz.
IN: ModelCARE 90: Calibration and Reliability in Groundwater Modelling. IAHS Publication No. 195. International Association of Hydrological Sciences, Washington, DC. 1990. p 373-384. 6 fig, 3 tab, 12 ref.

Descriptors: *Boundary conditions, *Calibrations, *Heat transfer, *Model studies, *Radioactive waste disposal, *Temperature effects, *Underground waste disposal, Advection, Aquifer characteristics, Convection, Data interpretation, Error analysis, France, Mass transfer, Mathematical analysis, Mathematical equations, Mathematical studies, Permeability, Sensitivity analysis, Temperature gradient, Uncertainty, Vertical distribution.

Investigations for the construction of a deep nuclear waste repository in France have led to the study of four possible sites in different geological formations: clay, granite, schists, and salt. The safety studies involve coupled modeling of heat, groundwater flow, transport, and chemistry. The choice of boundary conditions and the dependence of the temperature field on other coupled phenomena were modeled. Investigations were undertaken to determine appropriate upper, lower, and lateral boundary conditions in the modeling of underground heat transport. In addition, an examination of internal phenomena, such as aquifer advection and natural convection, was also undertaken. The results of the investigation revealed that, in most cases of nuclear waste disposal within deep saturated formations of low permeability, heat transfer could be simulated to a good approximation by a conduction model, with the following boundary conditions: fixed temperature at ground level (upper boundary), zero flux on lateral boundaries and geothermal flux on the lower boundary. The positions of these boundaries was chosen as a function of the required accuracy. (See also W91-07253) (Korn-PTT)
W91-07290

PLANE VERTICAL TURBULENT BUOYANT JET.
Patras Univ. (Greece). Dept. of Civil Engineering.
For primary bibliographic entry see Field 8B.
W91-07598

INFLUENCE OF APPLICATION RATE ON THE BACTERIAL MUTAGENICITY OF SOIL AMENDED WITH MUNICIPAL SEWAGE SLUDGE.
Texas A and M Univ., College Station. Dept. of Soil and Crop Sciences.
K. C. Donnelly, J. C. Thomas, C. S. Anderson, and K. W. Brown.
Environmental Pollution ENPOEK, Vol. 68, No. 1/2, p 147-159, 1990, 4 fig, 3 tab, 12 ref.

Descriptors: *Ames test, *Land disposal, *Mutagenicity, *Salmonella, *Sludge disposal, *Soil amendments, *Soil bacteria, *Waste disposal, *Water pollution effects, Analytical methods, Bioassay, Environmental impact, Lysimeters, Sludge, Sludge analysis, Soil contamination.

The mutagenic potential of two soils amended with municipal sewage sludge at two application rates was monitored over a two year period using Salmonella/microsome mutagenicity assay. Samples were collected from undisturbed monolith lysimeters of Weswood sandy clay (Fluventic Ustochrept) and Padina sandy loam (Grossarenic Paleustalf) amended with dried sewage sludge at 50 and 100 Mg/ha. Soil samples were collected and sequentially extracted with methylene chloride and methanol. The residues from these extracts were tested for mutagenicity at five doses with and without metabolic activation in Salmonella strain TA98. In general, the mutagenic potential of the amended soils of both application rates for the first 8 weeks following sludge application increased and then slowly decreased. The maximum mutagenic response observed in soil extracts was 222 revertants at a dose of 10 mg of residue. This response was induced by the methanol extract from the Weswood soil collected 56 days after the application of 50 Mg/ha sewage sludge as compared to the 100 mg/ha application which induced 202 revertants/mg. The mutagenicity of all fractions extracted from the sludge-amended soil at both application rates collected 717 days after application were not appreciably different from extracts from unamended soils. The data indicate that chemicals that were mutagenic in bacteria persist in the soil and that the higher application rates, as much as 2 years may be required for the mutagenic potential of the soil to return to background levels. (Author's abstract)
W91-07661

HAZARDOUS AND INDUSTRIAL WASTES: PROCEEDINGS OF THE 22ND MID-ATLANTIC INDUSTRIAL WASTE CONFERENCE.
For primary bibliographic entry see Field 5D.
W91-07662

IMPACT OF LAND DISPOSAL RESTRICTIONS ON HAZARDOUS WASTE SITE CLEANUPS.
Eckenfelder, Inc., Mahwah, NJ. Waste Management Div.
J. R. Caputi.
IN: Hazardous and Industrial Wastes: Proceedings of the 22nd Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 31-42. 4 tab, 12 ref.

Descriptors: *Cleanup operations, *Hazardous wastes, *Land disposal, *Regulations, *Site remediation, *Waste disposal, Resource Conservation and Recovery Act, Soil contamination, Superfund, Toxic wastes, Waste treatment, Wastewater disposal.

The Hazardous and Solid Waste Amendments to the Resource Conservation and Recovery Act, signed on November 8, 1984, include specific provisions restricting the land disposal of hazardous wastes. The purpose of the land disposal restrictions is to minimize the potential risk to human health and the environment by requiring the treatment of hazardous wastes prior to their land disposal. Two years later, Congress took an additional step towards phasing out land disposal of untreated hazardous waste in the Superfund Amendments and Reauthorization Act of 1986, which amended the Comprehensive Environmental Response, Compensation and Liability Act. This new law required EPA to select remedies in which treatment permanently and significantly decreased the toxicity, mobility, or volume of contaminants for the remediation of Superfund sites. Land disposal restrictions should be addressed in the early stages of the overall hazardous waste site cleanup program. Site investigations should include provisions for determining compliance with treatment standards. It is important to keep apprised of the in situ and on site treatment technologies being developed and demonstrated to be able to select the best remedy for a particular site. The land disposal restriction treatment standards should be determined for the waste codes applicable to the contaminated soils. There are a number of in situ and on site treatment technologies available for treating contaminated soils. Some of the in situ treatment technologies in use include vapor stripping, flushing, chemical fixation/stabilization, chemical oxidation, vitrification, radio frequency heating, and bioremediation. On site technologies include incineration, low temperature thermal stripping, stabilization/solidification, soil washing, chemical extraction, and biodegradation. Permitting requirements may inhibit the use of treatment technologies. Obtaining the required permits can often take an exceedingly long time and result in increased project costs. (See also W91-07662) (Mertz-PTT)
W91-07664

USE OF DAIRY WASTES TO SEAL POROUS SOILS.
Lafayette Coll., Easton, PA. Dept. of Civil Engineering.
T. J. McGhee, and M. L. Rachelson.
IN: Hazardous and Industrial Wastes: Proceedings of the 22nd Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 66-76. 5 fig, 2 tab, 7 ref.

Descriptors: *Hazardous wastes, *Land disposal, *Liners, *Soil sealants, *Waste disposal, *Waste utilization, Dairy industry, Environmental protection, Feasibility studies, Industrial wastes, Soil permeability, Whey.

The strict standards that have been established limiting release of contaminants from waste disposal sites have created a need for efficient and economical liners. Many states now require the use of double liners, generally consisting of a flexible synthetic membrane as the first barrier and compacted natural clay for the second. The feasibility of using whey or other dairy waste to create an inexpensive liner suitable for use in sanitary, industrial or hazardous waste disposal sites was investigated. Whey is the liquid by-product from the manufacture of cheese. The cheese contains nearly all the fat, protein and calcium and part of the lactose of the milk from which it is made. Whey has a high biological oxygen demand, which makes its utilization preferable to disposal and treatment in a wastewater system. The whey used in this study was a sweet whey produced as a by-product to the manufacture of cheddar cheese. Results showed that a definite decrease in soil permeability can be produced by application of whey. The variations observed in permeability during the study may be due in part to biological degradation of the material accumulated in the soil. Production of gas within the specimens could be an indication of anaerobic biological activity. The minimum permeability achieved during the study was not low enough to meet the standards for disposal site liners, but approached such levels. The relatively small size of the samples and the possibility that flow could occur at the boundary between the soil and the container, together with the inherent difficulty of measuring permeability reproducibly, prevent a definite conclusion with regard to the general usefulness of this material without further study. (See also W91-07662) (Mertz-PTT)
W91-07667

POSSIBLE RE-USE OF PETROLEUM CONTAMINATED SOILS AS CONSTRUCTION MATERIAL.
Lehigh Univ., Bethlehem, PA. Dept. of Civil Engineering.
H. Hijazi, and S. Pamukcu.
IN: Hazardous and Industrial Wastes: Proceedings of the 22nd Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 155-170. 13 fig, 5 tab, 11 ref.

Descriptors: *Construction materials, *Hydrocarbons, *Oil pollution, *Recycling, *Soil contamination, *Waste stabilization, Cohesion, Compressibility, Density, Economic aspects, Feasibility studies, Leaching, Permeability, Reclamation.

The feasibility of using stabilized petroleum contaminated soils as a construction material was investigated. The re-use capacities are predicted to be base or subbase course material in highway construction, embankment, structural filler and barrier material in other earthen structures. The critical parameters in design of these structures are strength, permeability, durability, compressibility and index properties of the construction material. A number of laboratory tests were conducted on artificially prepared fuel oil contaminated soil specimens. The specimens were mixed with lime, cement, fly ash, gypsum and attapulgite clay at different percentages. The contaminant selected was crude oil. Kaolinite clay was selected as the soil medium, since clays retain hydrocarbons more often than granular soils. The formula for percentages of the three components, namely soil, contaminant and additive were varied to achieve a systematic variation in the physical properties measured. The measured properties were unconfined compressive strength, tensile strength, cohesion, internal friction angle, density and permeability. Results showed that stabilization and re-use of fuel oil contaminated soils appeared to be a viable method of resource recovery and may prove economical for the construction industry. More research is needed on the leaching effect and durability of stabilized soils to conclude in favor of the proposed approach. The results showed that there is much potential for the stabilized oil contaminated soils to be used in construction projects. (See also W91-07662) (Mertz-PTT)
W91-07674

STABILIZATION OF CLASS F FLY ASH WITH LIME AND CEMENT.
Wayne State Univ., Detroit, MI. Dept. of Civil Engineering.
M. A. Usmen, and C. P. Chou.
IN: Hazardous and Industrial Wastes: Proceedings of the 22nd Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 171-192. 7 fig, 7 tab, 15 ref.

Descriptors: *Construction materials, *Fly ash, *Industrial wastes, *Road construction, *Waste stabilization, *Waste utilization, Cements, Density, Economic aspects, Lime, Moisture content, Waste disposal.

In recent years, use of various waste products in highway construction has gained considerable attention in view of the shortages and high costs of suitable conventional aggregates, increasing costs of waste disposal, and environmental constraints. Use of waste by-products as economical replacements for conventional materials such as natural soils and aggregates can alleviate disposal costs and environmental pollution, and conserve high quality highway materials for higher-priority uses. Fly ash, a by-product of the coal combustion process at power plants, is a case in point. In can be used effectively for various highway construction applications. Fly ash can be successfully stabilized with lime, cement, or lime and cement combinations to produce mixtures having adequate strength and durability characteristics. Addition of lime to fly ash results in increased optimum moisture content and decreased maximum dry density. Addition of cement does not change the optimum moisture content and maximum dry density appreciably. In general, cement stabilized fly ash produces higher strength than lime stabilized fly ash. Both the stabilizer content and curing time influence strength for cement stabilized fly ash in the short and intermediate term (7-56 days). The strength of lime-stabilized fly ash seems to be fairly insensitive to stabilizer content during the same period. Combined lime and cement stabilized fly ash shows properties intermediate between lime-stabilized and cement-stabilized fly ash. Addition of cement to lime-stabilized fly ash provides improved early strength. Durability of the stabilized mixtures can best be evaluated by residual strength and percent strength reduction in the vacuum saturation test. Durable mixtures of lime and/or cement stabilized fly ash can be produced by adding proper amounts of stabilizer and applying sufficient curing. (See also W91-07662) (Mertz-PTT)
W91-07675

STOCHASTIC ANALYSIS OF SOLUTE MOVEMENT IN COMPACTED SOIL LINERS.
Wisconsin Univ., Madison. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 5B.
W91-07676

TEST METHODS FOR THE EVALUATION OF TREATED SLUDGES FOR CONSTRUCTION PURPOSES.
Drexel Univ., Philadelphia, PA. Dept. of Civil Engineering.
S. Popovics.
IN: Hazardous and Industrial Wastes: Proceedings of the 22nd Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 243-250. 1 tab, 4 ref.

Descriptors: *Construction materials, *Materials testing, *Sludge stabilization, *Sludge utilization, *Testing procedures, *Waste utilization, Ash, Compressive strength, Density, Moisture content, Mud, Shear tests, Waste disposal, Waste stabilization.

Stabilization means an improvement of the properties of the sludge by blending it with inexpensive materials. It is shown, for instance, that red mud-fly ash combinations provided unconfined compressive strengths up to 500 psi at the age of 28 days; or, the combinations of red mud with waste gypsum provided over 5000 psi compressive strength. Methods that are suitable for testing stabilized solid wastes and their ingredients were examined. Application of some of these methods was illustrated with the stabilization of a sludge. The sludge in question was a clay-like material with a pH over 12. It was obtained by the extraction of aluminum from bauxite ore. The residue is called red mud in the trade and an estimated 30 million tons have been accumulated during the years. One method for the establishment of the needed liquid content in a stabilized waste is based on the moisture-density relationship. Another method for the establishment of the liquid content is based on the moisture-penetration resistance relationship. The shear resistance of a consolidated and drained stabilized waste specimen can be determined by a method which consists of placing the specimen in a direct shear device and applying a predetermined normal stress, then applying a shearing force to the shear the specimen. The compressive strength is usually determined on molded cylindrical specimens in an unconfined manner. Several such test methods have been specified for this process. Blending a solid waste or sludge, such as red mud with technically and economically suitable materials is an inexpensive technology for the improvement of mechanical as well as other properties of red mud. These test methods were suitable for the establishment of optimum compositions as well as the areas of applications of the stabilized waste. (See also W91-07662) (Mertz-PTT)
W91-07679

STABILIZATION AND UTILIZATION OF COAL ASH IN ENVIRONMENTAL APPLICATIONS.
West Virginia Univ., Morgantown. Dept. of Civil Engineering.
J. J. Bowders, and W. S. Almes.
IN: Hazardous and Industrial Wastes: Proceedings of the 22nd Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 251-266. 3 fig, 4 tab, 12 ref.

Descriptors: *Environmental engineering, *Fly ash, *Waste stabilization, *Waste utilization, Clays, Coal mining, Construction materials, Grouting, Landfill covers, Landfills, Permeability, Waste disposal, Water pollution control.

Fly ash, the fine residue which results from the burning of coal is being produced at the rate of 50 million tons per year. Eighty-five percent of this amount is simply placed in landfills or lagoons serving little productive use and in certain instances, resulting in degradation of the environment either aesthetically or physically such as through water pollution. At West Virginia University, several research projects aimed at producing useful materials from fly ash have been conducted or are on-going. Currently, two field research projects have been designed and are under various stages of implementation. Both of the projects demonstrate high volume utilization of fly ash in environmental applications. The first project consists of a cover for a one acre municipal solid waste landfill. The landfill has been closed for approximately two years. At this particular site, there is a limited supply of clay readily available from which the compacted clay cover could be constructed. Current testing involves use of the local clay as the fly ash amendment. Provided the permeability criterion is satisfied, the clay/fly ash mixture will also provide a flexible barrier--an important factor since the cover may undergo significant movement due to settlement of the underlying waste. The second project involves using fly ash grout. The purpose of the grout is to reduce the flow of groundwater into acidic spoil material that remains after the surface mining of coal. Grouts, consisting of fly ash and admixtures including cement, clay, or other waste materials will be injected into the acidic material in order to lower the permeability and thus reduce the quantity of the acid flow from the spoil. Field demonstrations projects are ongoing for the amended fly ash cover and the fly ash grout. Previous uses of fly ash in concrete and aggregate/soil stabilization applications have proven beneficial but the percentage of fly ash utilized in these applications is less than 20% of the 50 million tons produced per year. (See also W91-07662) (Mertz-PTT)
W91-07680

EVOLUTIONARY DEVELOPMENT--THE STATIONARY MIXING SYSTEM AT MONTGOMERY COUNTY REGIONAL COMPOSTING FACILITY.
O'Brien and Gere Engineers, Inc., Landover, MD.
J. S. Ireland, P. D. Guyer, and J. L. Thompson.
IN: Hazardous and Industrial Wastes: Proceedings of the 22nd Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 501-520. 10 fig.

Descriptors: *Composting, *Maryland, *Odor control, *Sludge treatment, *Waste disposal, *Waste utilization, *Wastewater treatment, Economic aspects, Maintenance, Materials handling, Mechanical equipment, Wastewater facilities.

Composting has evolved from the early claims of no objectionable odors and microbiologists' ignoring material handling considerations to the present large-scale plants with state-of-the-art process control and odor scrubbing. The evolution has produced public acceptance of composting for conversion of wastewater sludge to accepted landscaping material. One facility that has been a key in the evolution is Montgomery County Regional Composting Facility, in Silver Spring, Maryland, a suburb of Washington, D.C. The Montgomery County Regional Composting Facility is owned and operated by the Washington Suburban Sanitary Commission. It was designed to process up to a nominal rate of 400 wet tons of sludge per day, for a total of 2800 wet tons per week. Wood chips are used as a bulking agent. Optimization of the composting process, including improvement in the mixture quality, is expected to improve the moisture balance and make even more precise control of the chemical odor scrubbing possible. When the decision was made to aid in the odor control by installing a stationary mixing system, housekeeping, ease of maintenance, and operational reliability were prime considerations. Composting systems that have recognized the cost effectiveness of conventional conveying systems have generally had good operating success. Several modifications were added to the multiple-screw, live-bottom bin for wood handling. The sludge bins are also multiple-screw, live-bottom bins but have been adapted to the special characteristics of sludge. While the evolution continues, it is important to take a step back and emphasize quality control. For the Stationary Mixing System, it was decided to place system responsibility on a single material handling system supplier. Problems with material handling have discouraged consideration of composting as a viable method of residuals disposal. However, design of each new composting plant has evolved from the earlier composting plants to minimize the material handling problems. (See also W91-07662) (Mertz-PTT)
W91-07696

NIAGARA FALLS EVALUATES UNIQUE APPROACH TO REDUCING HIGH SLUDGE DISPOSAL COSTS.
P. J. Psaris, M. D. Noriega, R. E. Game, R. R. Roll, and A. B. Cooper.
IN: Hazardous and Industrial Wastes: Proceedings of the 22nd Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 521-541. 7 fig, 2 tab.

Descriptors: *Cost analysis, *Land disposal, *Sludge disposal, *Sludge drying, *Sludge treatment, *Wastewater management, Economic aspects, Filter presses, Incineration, New York, Wastewater facilities, Wastewater treatment.

The City of Niagara Falls, New York operates a sophisticated wastewater treatment plant located adjacent to the Niagara River and Falls. In the mid-1970's the 48 million gallon/day physical-chemical wastewater treatment plant was built to treat a combination of domestic and industrial wastewater. Over two-thirds of the incoming wastewater excluding infiltration/inflow is from industrial wastewater sources. Due to the plant's physical-chemical processes and the high percentage of industrial wastewater, a unique sludge is produced. The city has historically relied on vacuum filter dewatering and commercial landfill disposal of sludge and other residuals. During recent years the cost of landfill disposal has dramatically increased. A sludge management study was initiated in 1988 the characterize residuals and determine alternative sludge disposal routes. Several recommendations can be based on the study results. Install new belt filter presses to replace the vacuum filter for dewatering the wastewater treatment plant sludge. Belt filter presses should result in a savings of operation and disposal costs. Pilot test heat dryers to confirm the viability of this option and explore the equipment options available. If pilot test proves heat drying to be practical, then design and install a heat drying system. This system should allow for landfilling at several sites, combustion off-site, co-combustion with industry, or dedicated land disposal of the heat dried material. If heat drying is not practical, design and install one new incinerator with a lime stabilization system as backup. (See also W91-07662) (Mertz-PTT)
W91-07697

DURABILITY TESTING OF A STABILIZED PETROLEUM SLUDGE.
Bucknell Univ., Lewisburg, PA.
S. J. Zarlinski, and J. C. Evans.
IN: Hazardous and Industrial Wastes: Proceedings of the 22nd Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 542-556. 5 fig, 7 tab, 19 ref.

Descriptors: *Durability, *Oil wastes, *Site remediation, *Sludge lagoons, *Sludge stabilization, *Waste disposal, *Waste stabilization, *Waste utilization, Compressibility, Industrial wastes, Organic carbon, Permeability, Sludge treatment, Solidification.

In the past, the production of fine lubricating oil by petroleum refineries resulted in large quantities of an acidic sludge. The production process, typically employed until the early 1970's, included the addition of sulfuric acid to the crude oil to assist in removal of impurities. For the site under study, the waste sludge was disposed of in open lagoons. Various remedial techniques have been identified for the lagoon site. A three-year research project has been undertaken to investigate the effectiveness of stabilization/solidification. The first year of the project included a bibliographic search of existing literature and a survey of stabilization vendors. As a result of these studies, stabilization reagents were chosen and a laboratory methodology was developed for testing the stabilized material. The second year of the research focused on the laboratory investigation. Since the start of the project, some 250 mixes were tested to study the stabilization effectiveness. Results showed that the unconfined compressive strength increases with longer curing times. The ultimate strength is obtained at the 28 day cure time, when strength either remains constant or decreases. In the short-run, each mix obtains at least a 70% reduction of the total organic carbon concentration. With increased curing times, the total organic carbon reduction decreases. No physical degradation was apparent for each mix during the wet/dry testing. The average volume change was 1.47% and the average material loss was 9.3%. The stabilized samples have compression indices equivalent to those of a stiff clay. The permeability of the samples were .000002 cm/second. Preliminary results showed that the permeation of water may cause the release of encapsulated organics. (See also W91-07662) (Mertz-PTT)
W91-07698

EVALUATION OF SILICON SLAG AS A LEACHATE FLOW MEDIUM.
Buchart-Horn, Inc., York, PA.
A. A. Memon, and W. F. Downey.
IN: Hazardous and Industrial Wastes: Proceedings of the 22nd Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 559-569. 4 fig, 1 tab, 4 ref.

Descriptors: *Landfills, *Leachates, *Liners, *Slag, *Waste disposal, *Water pollution prevention, Construction materials, Design criteria, Land disposal, Regulations, Silicon, Transmissivity, Waste utilization.

Materials used as the leachate flow media for leachate collection and liner leak detection are important in a sanitary landfill design. Therefore, regulations require a leachate flow medium to be structurally sound in order to withstand the stresses and be of proper composition and size to facilitate rapid flow of leachate. Electric Furnace Silicon Slag has been proposed as a medium in the leachate collection and detection zones. Tests performed and economic analysis conducted in this case indicate that using electric furnace silicon slag for a leachate flow medium is a viable and often advantageous option. Not only does electric furnace silicon slag meet the design criteria and performance standards, but in some ways exceeds them. To optimize the fluid transmissivity and maintain structural cohesion the size of the grains should not exceed 1.0 inch diameter and be a minimum of 0.25 inch diameter. Therefore, an equivalency approval from the regulatory agency will be necessary. In economic terms, Pennsylvania electric furnace silicon slag is three times cheaper than pea size quartz gravel. Although screened quartz gravel meets size and chemical inertness requirements, it does not have stable placement and high permeability characteristics comparable to those of the slag. In the final analysis, however, final selection of the material as a leachate flow medium will be determined based on

cost, availability and likelihood of regulatory approval. (See also W91-07662) (Mertz-PTT)
W91-07699

EVALUATION AND ANALYSIS FOR SUBSIDENCE OF STABILIZED SLUDGE.
Du Pont de Nemours (E.I.) and Co., Newark, DE. Engineering Dept.
F. J. Biehl, and J. S. Browning.
IN: Hazardous and Industrial Wastes: Proceedings of the 22nd Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 594-609. 6 fig, 1 tab, 6 ref.

Descriptors: *Land disposal, *Landfills, *Sludge stabilization, *Subsidence, *Waste containment, *Waste disposal, Consolidation, Hazardous wastes, Industrial wastes, Landfill covers, Leachates, Permeability, Slope degradation, Sludge disposal, Testing procedures.

In the field of stabilization/solidification of a hazardous or industrial sludge waste, regulatory agencies such as the U.S. EPA have emphasized strength, leachate generation, and leachate pollutant concentration as the parameters of interest in pilot-scale and full-scale operations. An area of concern which none of these parameters addresses is subsidence of the stabilized/solidified waste matrix. Subsidence of stabilized sludges in capped landfills may lead to slope failure, ponding of water on top of the cap, and could threaten the integrity of geosynthetic components of the landfill cap. To prevent these problems from occurring, consolidation and permeability testing of stabilized sludges should be performed. Consolidation testing was performed on a stabilized organic sludge in order to evaluate subsidence potential. Initial data reduction appeared to indicate that subsidence of the stabilized material could be accurately modelled using conventional consolidation procedures typically used for soils. However, values obtained for the coefficient of consolidation were proven invalid based upon permeability test results. Estimation of the coefficient of consolidation, based on permeability values and observed compression under applied stress increments, indicate that the majority of the observed deformation was due to secondary consolidation mechanisms. Long-term creep testing was recommended for stabilized sludges, particularly those that were expected to be creep prone. Unlike silt and clay soils that deform mostly by means of primary consolidation, the stabilized sludge deforms over a long period of time due to creep. Thus, one should design stabilized sludge landfills and impoundments for long-term deformation to prevent failure of landfill covers and slope failure. (See also W91-07662) (Mertz-PTT)
W91-07702

LEACHATE CHARACTERISTICS FROM INCINERATOR ASH MONOFIL AND LANDFILL FOR ASH-MSW CO-DISPOSAL.
C. P. C. Poon, and B. J. Chu.
IN: Hazardous and Industrial Wastes: Proceedings of the 22nd Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 613-625. 6 tab, 3 ref.

Descriptors: *Acid rain effects, *Ash, *Hazard assessment, *Landfills, *Leachates, *Toxicity, Cadmium, Hazardous wastes, Incineration, Land disposal, Lead, Municipal wastes, Waste management.

A potential exists for the ash residue generated by incinerators of municipal solid wastes (MSW) to be classified as a hazardous waste. Of particular concern are the properties of the bottom ash and fly ash, which comprise the largest portion of these residues, and whether alone, or combined, these components constitute a hazardous waste requiring disposal pursuant to the requirements set forth in 40 Code of Federal Regulations Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities. Two columns were set up for leachate study. One received ash-residue only and the other received ash and municipal solid waste in a 1/3 ash/municipal solid waste ratio. Simulated acid precipitations were applied. Leachates were collected over a period of eleven months for analyses. Results showed that no greater percentage of organo-complex of Pb or Cd was formed than in the monofil. It can be concluded from the results that no hazardous levels of Pb and Cd would be found in the leachate from either a monofil disposal of incinerator ash-residue or a co-disposal landfill of ash-residue/municipal solid waste at a 1/3 weight ratio. The Toxic Characteristic Leaching Procedure extraction protocol of US EPA simulates a landfill scenario, allowing acetic acid as the leaching medium. However, the low pH at 2.9 is a far cry from the pH of most landfill leachate. A pH of 5.0 is lower than most landfill leachate and over-estimates the potential of leaching out chemicals from landfills. (See also W91-07662) (Mertz-PTT)
W91-07703

HAZARDOUS WASTE DISPOSAL IN RELATIONSHIP TO RADON GAS EMANATION IN ATMOSPHERE.
Lehigh Univ., Bethlehem, PA. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W91-07709

UNIVERSITY ROLE IN HAZARDOUS WASTE MANAGEMENT: FACULTY PUBLICATIONS, TEACHING, AND RESEARCH.
Argonne National Lab., IL. Energy and Environmental Systems Div.
R. W. Peters, C. A. Wentz, and F. Cadena.
IN: Hazardous and Industrial Wastes: Proceedings of the 22nd Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 718-740. 11 fig, 3 tab, 5 ref.

Descriptors: *Education, *Hazardous wastes, *Publications, *Research priorities, *Universities, *Waste management, Data collections, Environment, Environmental engineering, Journals, Research, Water pollution.

The major environmental journals were surveyed over the six year period of 1983 to 1988. There has been a general increase in the percentage of hazardous waste oriented publications in the field. Environmental Progress and Hazardous Waste & Hazardous Materials had the highest percentage of hazardous waste management publications. The overall percentage of hazardous waste related papers in the five journals over the six year period was 18.71%. The majority of the publications relating to hazardous wastes in the five journals were authored by the academic sector. This is likely due to the greater emphasis and increased pressure to publish in refereed journals as compared with the other affiliation categories. The consultant and industrial sectors constitute a large percentage of the authorships of hazardous waste oriented publications in Environmental Progress and the Journal of the Water Pollution Control Federation. Academia has not been actively involved to date in source reduction/waste minimization either in terms of research or teaching. There has been a decrease in the percentage of environmental research funding in terms of the percentage devoted to the hazardous waste field. The case history indicated that the university departments have emphasized specialization within their own field since the mid 1970s, placing less emphasis in environmental engineering electives. (See also W91-07662) (Mertz-PTT)
W91-07710

ROTARY KILN INCINERATION SYSTEMS: OPERATING TECHNIQUES FOR IMPROVED PERFORMANCE.
Four Nines, Inc., Plymouth Meeting, PA.
J. J. Santoleri.
IN: Hazardous and Industrial Wastes: Proceedings of the 22nd Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 743-758. 10 fig, 10 ref.

Descriptors: *Incineration, *Operating policies, *Pollution control, *Rotary kilns, *Sludge disposal, *Waste disposal, *Water treatment, Industrial wastes, Municipal wastes, Resource Conservation and Recovery Act, Slurries, Soil contamination, Waste treatment facilities.

Experience in operation of rotary kilns goes back many years with thousands of kilns throughout the world. However, much of this experience is in the cement, lime, and calcined dolomite industries. In the past 20-30 years, this concept has been used in the incineration of municipal and industrial wastes. The operating practices differ in that the processing kilns are used to generate a quality controlled product. Flame size and shape, heat transfer by radiation and convection temperature distribution, and contact time all play a critical part in the quality of the end product. These kilns are normally 50-200 m (150-600 feet) in length. Kilns used for incineration are batch fed with solids of varying shape, size, and heat content. This provides flexibility not available in other incinerator systems. The kiln may also burn liquids, slurries, sludges and contaminated soils at a continuous feed rate. The Resource Conservation and Recovery Act (RCRA) establishes the performance necessary to obtain an operating permit. Many existing kilns have been modified in design and operating practices to allow the system to meet RCRA standards. These modifications have included feed devices, seals, lance design and location, controls, scrubber systems, monitors, and safety devices. Modifications in design and operation have worked to minimize fugitive emissions, temperature, pressure and stack emission upsets. These have provided systems whose performance insures a safe environment to the owner and the surrounding community. (See also W91-07662) (Author's abstract)
W91-07711

RECYCLING OF INSULATION FIBERGLASS WASTE WITH A NEW VITRIFICATION PROCESS.
Vortec Corp., Collegeville, PA.
For primary bibliographic entry see Field 5D.
W91-07712

METHODOLOGY FOR DEVELOPING BEST DEMONSTRATED AVAILABLE TECHNOLOGY (BDAT) TREATMENT STANDARDS.
Environmental Protection Agency, Washington, DC. Office of Solid Waste.
For primary bibliographic entry see Field 5G.
W91-07808

FATE OF POLYCYCLIC AROMATIC HYDROCARBONS DURING SEWAGE SLUDGE DIGESTION.
Imperial Coll. of Science and Technology, London (England). Dept. of Civil Engineering.
P. W. W. Kirk, and J. N. Lester.
Environmental Technology (Letters) ETLEDB, Vol. 12, No. 1, p 13-20, 1991. 3 fig, 5 tab, 19 ref.

Descriptors: *Polycyclic aromatic hydrocarbons, *Sludge digestion, *Wastewater treatment, Anaerobic digestion, Sludge disposal.

The potential of anaerobic sludge digestion to ameliorate the effects of polycyclic aromatic hydrocarbons following sludge disposal is largely unknown. The removal of 14 polycyclic aromatic hydrocarbons was studied in batch incubations both with and without the addition of sodium azide to arrest biological activity. Statistically significant removals of benzo(ghi)perylene, indeno(1,2,3-cd)pyrene, and coronene were observed over 32 days of incubation. A small but statistically significant increase was observed in the case of benzo(b)naphtho(2,1-d)thiophene. Anaerobic digestion over a period of 32 days had no statistically significant effect on the concentrations of anthracene, fluoranthene, pyrene, benzo(c)phenanthrene, benzo(b)fluoranthrene, benzo(a)anthracene, chrysene, benzo(e)pyrene, benzo(k)fluoranthrene, and benzo(a)pyrene in both active and azide-treated sludges. The mechanism of removal for the 3 compounds significantly removed appears to be non-biological, since removal occurred in the presence or absence of sodium azide with no significant difference in removal when comparing the two. Further study is required to elucidate the mechanism of removal. (Doria-PTT)
W91-07856

DEWATERING PROCESS CHANGES BOOST SLUDGE INCINERATOR EFFICIENCY.
Tutela Engineering Associates, Inc., Cranston, RI.
D. Tutela, and J. Columbo.
Water Environment & Technology WAETEJ, Vol. 3, No. 2, p 9, February 1991.

Descriptors: *Incineration, *Sludge disposal, *Sludge drying, *Waste disposal, *Wastewater treatment, Activated sludge process, Chemical treatment, Cost analysis, Landfills, Polymers, Rhode Island, Sludge conditioning.

By 1989, sludge incineration at the 1-cu m/sec (23-MGD) activated sludge wastewater treatment facility in Cranston, Rhode Island, had become unreliable and costly. The problems with incineration were related partly to high, but unnecessary, amounts of inert and non-volatile sludge conditioning agents (lime and ferric chloride) used in dewatering. Besides significantly reducing incinerator throughput, the high amount of non-volatile material in the dewatered sludge severely lowered the cake's thermal value. Large amounts of natural gas had to be added to promote burning. After analysis, polymer was substituted as a sludge conditioning agent. Incinerator controls and instrumentation were replaced and recalibrated to bring the unit back to good operating condition. A computerized maintenance program was installed, placing preventive maintenance of the presses and incinerator on a tight schedule. The switch to polymer has provided cleaner, shorter, and more efficient sludge incineration with a significantly increased throughput. Ash generation has been reduced, with resulting decrease in landfill costs and the plant now receives and treats outside septage, generating $50,000/mo in additional revenue for the city. (Rochester-PTT)
W91-07895

SLUDGE MANAGEMENT IN SAN DIEGO.
Serpentix Conveyor Corp., Westminster, CO.
R. E. Nissen, and W. E. Stanfill.
Water Environment & Technology WAETEJ, Vol. 3, No. 2, p 13-16, February 1991.

Descriptors: *California, *San Diego, *Sludge utilization, *Wastewater management, *Wastewater treatment, *Water reuse, Centrifugation, Cost analysis, Impaired water use, Reclaimed water, Rehabilitation, Sludge drying, Waste management.

As part of a $200 million sludge and water reclamation center for San Diego (California), a new remote sludge-drying facility (SDF) will be constructed to replace the current 30-bed air drying on Fiesta Island. The new plant is expected to cost about $65 million and will be the first of several facilities to be constructed on a 34-acre site. Completion of the SDF will be followed by installation of a second facility on the site, a water reclamation plant (WRP). The WRP is estimated to cost $150 million and will reclaim treatment-plant water and make it suitable for irrigation of residential, community, and commercial projects and for other non-potable uses. Sludge from the WRP will go to the SDF for drying and disposal of artificial use. A sludge-composting plant may be added to the site. Activity already under way on the SDF is for first-phase construction of a 32 km-long, 305 mm-diameter line for pumping Point Loma sludge to the new SDF. The SDF is expected use 10-12 high-efficiency centrifuges capable of producing 30% solids. Indirect-heating dryers will further dry the sludge to as high as 90% solids. With the completion of the new SDF, all signs of the old sludge-drying operation on Fiesta island must be removed and the site returned to its natural state. All 30 drying beds will be filled in and the land contoured and seeded to ensure the quickest return to a natural state. (Rochester-PTT)
W91-07896

TREATMENT OF LEACHATE FROM LANDFILL SITES--STANDARDS, RESULTS OF OPERATION AND COST (LEISTUNGS- UND KOSTENVERGLEICH VON DEPONIESICKERWASSER-RERINIGUNGSANLAGEN MACH DERZEITIGEM STAND DER TECHNIK).
Witten-Herdecke Univ., Witten (Germany, F.R.). Lehrstuhl fuer Umwelttechnik und Umweltmanagement.
K. U. Rudolph, K. E. Koppke, M. Gellert, and A. Rudolph.
Interim Report No. 02-WA 8721/0, October 1988. 230p, 33 fig, 33 tab, 136 ref, 2 append. English summary.

Descriptors: *Landfills, *Leachates, *Waste disposal, *Waste treatment, *Wastewater treatment, Activated carbon, Adsorption, Ammonia, Biological treatment, Chemical oxygen demand, Chemical precipitation, Chemical treatment, Economic aspects, Filtration, Flocculation, Nitrogen compounds, Reverse osmosis.

Standards of 500 microgm AOX/L, 50 mg NH4-N/L, 200 mg COD/L or resp. 5% remaining chemical oxygen demand (COD) for landfill leachates, can be achieved with four technologies: biological treatment with surplus activated carbon adsorption and precipitation, flocculation/precipitation with surplus filtration and reverse osmosis, two-step evaporation with prestripper, and two-step reverse osmosis. Only the last can realize a level of fish toxicity with GF=2 (GF: dilution index). A market price-based calculation results in total costs of $7-$10/cu m of purified leachate for all of these technologies except evaporation, which costs significantly more. Waste air purification and final treatment and disposal of solid waste from the process is not yet being practiced, and is not included in this calculation. (Author's abstract)
W91-07914

ISOTOPE STUDIES OF THE HYDROLOGY OF THE GORLEBEN AREA, FRG.
Bundesanstalt fuer Geowissenschaften und Rohstoffe, Hanover (Germany, F.R.).
For primary bibliographic entry see Field 2F.
W91-07970

ANALYSIS OF POLYCHLORINATED DIBENZO-P-DIOXINS (PCDD) AND POLYCHLORINATED DIBENZOFURANS (PCDF) IN SOIL AND DIGESTED SEWAGE SLUDGE FROM STOCKHOLM, SWEDEN.
Stockholm Univ. (Sweden). Dept. of Zoology.
D. Broman, C. Naf, C. Rolff, and Y. Zebuhr.
Chemosphere CMSHAF, Vol. 21, No. 10/11, p 1213-1220, 1990. 2 fig, 3 tab, 7 ref.

Descriptors: *Chlorinated hydrocarbons, *Non-point pollution sources, *Sludge disposal, *Sludge utilization, *Soil contamination, Dioxins, Polychlorinated dibenzofurans, Stockholm, Sweden, Toxicity.

The content of polychlorinated dibenzo-p-dioxins (PCDD) and polychlorinated dibenzofurans (PCDF) in sewage sludge samples and top soils from fields situated in the county of Stockholm has been investigated. Further, the contribution of PCDDs and PCDFs to the fields from sewage sludge was compared with the contribution from two non-point emission sources, i.e. road traffic and the urban area of the city of Stockholm. The mean concentration in four analyzed sludge samples was 79 pg toxic equivalents (TEQ/g) (organic weight; o.w.). Soil samples taken close to major roads varied between 13 and 49 pg TEQ/g (o.w.) and soil samples which were not taken close to major roads varied between 9 and 32 pg TEQ/g (o.w.). The results indicate that both road traffic and outlets from the urban area influence the PCDD and PCDF concentrations in the arable soil. Fertilization with sludge (1 tonne dry weight/hectare/year) raises the initial soil concentrations of PCDD and PCDF in the fields by approximately 2-3%. (Author's abstract)
W91-08020

LABORATORY DIFFUSION TESTING FOR WASTE DISPOSAL: A REVIEW.
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
C. D. Shackelford.
Journal of Contaminant Hydrology JCOHE6, Vol. 7, No. 3, p 177-217, February 1991. 8 fig, 3 tab, 94 ref.

Descriptors: *Analytical methods, *Diffusion coefficient, *Land disposal, *Reviews, *Soil tests, *Waste disposal, Chemical wastes, Diffusion, Laboratory methods, Literature review, Soil properties, Soil saturation, Soil texture, Solute transport.

The laboratory measurement of diffusion coefficients of chemical waste constituents in fine-grained soils is reviewed. Laboratory methods for determining liquid phase diffusion coefficients comprise both steady-state and transient methods. The transient methods include the column method, the half-cell method, the double reservoir method and the single reservoir method. Two methods for saturating unsaturated soils prior to the start of diffusion testing are the permeation method and the soaking method. Extraction of contaminant species from the soil at the end of diffusion testing may is accomplished by high-pressure pore water squeeze, chemical extraction, or chemical digestion methods. A summary of effective diffusion coefficients from the literature suggests that the major physical factor affecting the value of the measured diffusion coefficient is the degree of saturation of the soil, with values for nonreactive and reactive solutes in saturated soils being as much as 10-20 times higher than the corresponding values in unsaturated soils. Most of the other physical factors only become important in soils which are highly unsaturated. In addition, the diffusive transport rates of reactive solutes subject to reversible sorption reactions can be as much as 5000 times lower than those of nonreactive solutes in saturated soils and from 20 to 630,000 times lower in unsaturated soils. (MacKeen-PTT)
W91-08039

OPTIMUM RESIDENCE TIME (IN CSTR AND AIRLIFT REACTOR) FOR BACTERIAL LEACHING OF METALS FROM ANAEROBIC SEWAGE SLUDGE.
Institut National de la Recherche Scientifique, Sainte-Foy (Quebec).
D. Couillard, and G. Mercier.
Water Research WATRAG, Vol. 25, No. 2, p 211-218, February 1991. 6 fig, 4 tab, 43 ref. Natural Science and Engineering Research Council of Canada Grant OGP0003711 and Ministere de l'Education du Quebec Grant FCAR EQ-3029.

Descriptors: *Heavy metals, *Leaching, *Retention time, *Sludge disposal, *Sludge treatment, Bacteria, Cadmium, Comparison studies, Copper, Kinetics, Land disposal, Manganese, Metals, Nickel, Optimization, Zinc.

The bacterial process of metal solubilization from sewage sludges was studied using two types of reactors: a continuously stirred tank reactor (CSTR) and an airlift reactor, with partial sludge recycling in each case. Both reactors showed similar metal solubilization efficiencies. After parameter optimization and steady state were obtained, a mean hydraulic residence time of 0.75 day allowed 91% Cu, 94% Zn, 93% Mn, 67% Ni, and 67% Cd solubilization in the CSTR, while 89% Cu, 91% Zn, and 82% Cd were solubilized in the airlift reactor. The equation r sub v = 1.23C + 0.44, expressing the solubilization rate of Cu or Zn according to their respective concentrations, had an explained variance (r squared) of 0.93 for a mean hydraulic residence time (t bar) of 0.75 d. This equation applies equally to the CSTR and to the airlift, thus showing the equality of the efficiency of either reactor. A significant first order kinetic equation has been formulated for each t bar. The results represent a 4:1 reduction of the required t bar in comparison to t bar used in earlier work and 0.75 day is therefore an optimum mean hydraulic residence time for bacterial leaching of metals from anaerobic sewage sludge. (Author's abstract)
W91-08056

WASTEWATER GROWN WATERHYACINTH AS AN INGREDIENT IN RABBIT FOOD.
Florida Univ., Gainesville. Dept. of Small Animal Clinical Sciences.
For primary bibliographic entry see Field 5D.
W91-08074

IMPORTANCE, DETERMINATION, AND OCCURRENCE OF INORGANIC CHEMICAL CONTAMINANTS AND NUTRIENTS IN SOUTH AFRICAN MUNICIPAL SEWAGE SLUDGES.
Council for Scientific and Industrial Research, Pretoria (South Africa). Div. of Water Technology.
R. Smith, and H. Vasiloudis.
Water SA WASADV, Vol. 17, No. 1, p 19-30, January 1991. 19 fig, 7 tab, 35 ref.

Descriptors: *Sludge, *Sludge analysis, *Sludge utilization, *South Africa, Chemical analysis, Heavy metals, Hydrogen ion concentration, Land disposal, Metals, Municipal wastewater, Nitrogen, Nutrients, Phosphorus, Pollutant identification, Spectral analysis, Standards.

Twelve major inorganic chemical contaminants were identified as being commonly present in municipal sewage sludges, and suitable analytical methods were developed and tested for their determination, as well as for the determination of the major nutrients commonly present in such sludges. Samples of air-dried sludge were collected from 77 South African sewage works and analyzed for both inorganic chemical contaminant and nutrient content. Comparison of the results obtained for inorganic chemical contaminants in South African sludges with those obtained for UK sludges showed that in only three cases, i.e. copper, lead and selenium, were the maximum range values signifiantly higher for South African sludges than for UK sludges. UK 'common' values were higher than South African median values for all contaminants. These results were used in conjunction with previous work conducted by the National Institute for Water Research (CSIR) and with reference to limits laid down by various overseas countries, to prepare a set of suggested guidelines for the application of disinfected sewage sludge to agricultural lands. Of the 77 sludges analyzed, 45 were found to have met the suggested guidelines, 16 were over the suggested maximum permissible concentrations in the case of one contaminant only, while the remaining 16 exceeded the maximum concentrations for two or more contaminants. (Doria-PTT)
W91-08089

MECHANISMS OF INORGANIC PARTICLE FORMATION DURING SUSPENSION HEATING OF SIMULATED AQUEOUS WASTES.
Massachusetts Inst. of Tech., Cambridge. Dept. of Chemical Engineering.
J. A. Mulholland, and A. F. Sarofim.
Environmental Science and Technology ESTHAG, Vol. 25, No. 2, p 268-274, February 1991. 7 fig, 29 ref, 2 append. EPA prime contract 68-02-4247.

Descriptors: *Aerosols, *Air pollution sources, *Cadmium, *Heavy metals, *Lead, *Nickel, *Particulate matter, Ash, Distribution, Fate of pollutants, Incineration, Particle size, Pollutant identification.

Ultrafine inorganic particles are generated by incinerators that are difficult to capture by electrostatic precipitation can penetrate the deep lung when inhaled, and may result in a rise in concentration of metals in the major sinks of soil and water. They may also provide a signature for source attribution. The fate of cadmium, lead, and nickel in compounds nitrate in aqueous droplets was studied in a laboratory-scale furnace, and trimodal particle size distributions were observed. Metal partitioning between a residual mode (particle aerodynamic diameter D > 7 microns) and an intermediate mode (1 micron > D > 7 microns) was consistent with the dependence of particle porosity on condensed-phase transformations during nitrate decomposition. In addition, ultrafine particles were produced. In the nickel experiments, where vaporization was not a reasonable mechanism for inorganic aerosol formation, it was found that 30-35% of the particles had aerodynamic diameters of less than 1 micron. Furthermore, a preponderance of cenospheres was observed in the large particle size fractions. It is conjectured that the fragmentation process of cenosphere bursting produced the submicron aerosol. In the cadmium and lead experiments, the amount of submicron particles produced was in qualitative agreement with the amount of metal oxide calculated to vaporize. (Doyle-PTT)
W91-08100

ON-SITE RECYCLING OF HAZARDOUS WASTE SOLVENTS.
California Univ., Davis.
S. I. Schwartz, W. B. Pratt, and D. R. McCubbin.
Journal of Environmental Systems JEVSBH, Vol. 20, No. 1, p 1-21, 1990/1. 1 fig, 5 tab, 13 ref.

Descriptors: *Hazardous waste disposal, *Industrial wastes, *Recycling, *Solvents, Cost analysis, Distillation, Economic aspects, Economic evaluation.

Small-scale recycling on site is promising for solvents, paints, adhesives, and coolants. Among the benefits are reduced costs for new materials and disposal, and recovering chemicals from wastes uses less energy than producing them from raw materials. The economic desirability of recycling depends on whether it produces enough economic benefits in reduced solvent and disposal costs to pay back the purchase and operating costs of the recycling device. Two baseline studies were used to model the comparative economics of on site solvent recycling. Firms that generate just over the 1,000 gallon per month limit for small quantity generators, and auto repair shops that generate less than 100 gallons per month were used. Net present values and rates of return were calculated in each situation together with sensitivity analysis and break-even analysis to examine how good the devices are under conditions that depart from the baselines. Results show that the device is very profitable for firms generating 100 gallons per month but for firms generating only 20-30 gallons per month of solvent, the device is not economically desirable under some conditions. Policy measures that would enhance device desirability include; free collection of distillation residues, grants to reduce capital costs of the equipment, and an investment tax credit. (Doyle-PTT)
W91-08110

COMPREHENSIVE SLUDGE MANAGEMENT PLANNING FOR THE HYPERION TREATMENT PLANT (LOS ANGELES, USA).
Montgomery (James M.) Consulting Engineers, Inc., Pasadena, CA.
For primary bibliographic entry see Field 5D.
W91-08125

SLUDGE MANAGEMENT AND DISPOSAL PRACTICES OF THE COUNTY SANITATION DISTRICTS OF LOS ANGELES (USA).
Los Angeles County Sanitation Districts, Whittier, CA.
For primary bibliographic entry see Field 5D.
W91-08126

SEWAGE AND SOLIDS DISPOSAL: ARE PROCESSES SUCH AS OCEAN DISPOSAL PROPER--THE CASE OF RIO DE JANEIRO (BRAZIL).
Companhia Estadual de Agua e Esgotos do Rio de Janeiro (Brazil).
E. P. Jordao, and J. R. Leitao.
Water Science and Technology WSTED4, Vol. 22, No. 12, p 33-43, 1990. 5 fig, 2 tab, 8 ref.

Descriptors: *Brazil, *Ocean dumping, *Rio de Janeiro, *Submarine outfall, *Wastewater disposal, *Wastewater outfall, Case studies, Coliforms, Dissolved oxygen, Environmental impact statement, Public health, Self-purification.

Although Brazilian federal regulations permit ocean disposal of sewage and solids, submarine outfalls must be studied and a report on the environmental impact produced. The State of Rio de Janeiro has monitored its Ipanema Submarine Outfall (IPO) since 1974, one year prior to going into operation. Present flow is 6 cu m/sec (140 mgd) of bar-screened domestic sewage. The submarine outfall is 2.4 m-diameter concrete pipe, 4.3 km long, and discharging at a depth of 27 m. Under the 1986 Act governing the use of the marine environment, the IPO has been investigated in terms of its public health effects, aesthetic effects, and effects on marine ecology. No ecological impact on the marine ecosystem was noted in relation to IPO. Studies of the biota, dissolved oxygen, and grease degradation have confirmed that sewage treatment in the marine ecosystem occurs in an efficient way. Despite this numerous groups have blamed the IPO for beach pollution. In fact, other agents are often responsible. Coliform problems at the beaches are due to problems with the city sewer network in handling storm runoff. Rochester-PTT)
W91-08127

MANAGING CHANGE IN AN ENVIRONMENTALLY CONSCIOUS SOCIETY: A CASE STUDY, GOTHENBURG (SWEDEN).
Goeteborg Regional Sewerage Co. (Sweden).
P. Balmer, and R. C. Frost.
Water Science and Technology WSTED4, Vol. 22, No. 12, p 45-56, 1990. 4 fig, 2 tab, 6 ref.

Descriptors: *Planning, *Public participation, *Sludge disposal, *Social aspects, *Sweden, *Waste management, *Wastewater treatment, Gothenburg, Incineration, Sludge drying, Underground waste disposal, Wastewater disposal.

The treatment and disposal of sewage sludge is in environmentally conscious societies is becoming increasingly problematical due, in large part, to public attitudes. A case study was conducted of a large wastewater treatment plant at Gothenburg, Sweden. Three radically different alternatives to the current practice of lime addition to dewatered raw sludge and disposal on land were appraised using a common set of criteria. The options considered were: (1) incineration, (2) drying of dewatered, anaerobically digested sludge, and (3) disposal of anaerobically digested sludge to underground cavities. The appraisal process involved the production of a report describing the alternatives in layman's language. The report was presented at a seminar with about 100 participants. Subsequently, two public meetings were held. Ultimately, the third option was chosen, although it was felt generally that this represented a waste of a resource of agricultural value. Underground disposal was accepted with the proviso that the time gained by using the underground disposal option (21-35 years, depending on the sludge solids content) should be used to develop techniques of producing a cleaner sludge that would make reuse an acceptable option. (Rochester-PTT)
W91-08128

DRYING OF SEWAGE SLUDGE: AN IMPORTANT STEP IN WASTE DISPOSAL.
Ingenieurbuero fuer Verfahrens- und Chemieingenieurtechnik, Zurich (Switzerland).
For primary bibliographic entry see Field 5D.
W91-08129

EVALUATING THE IMPACTS OF SLUDGE INCINERATION USING A RISK BASED APPROACH.
Montgomery (James M.), Inc., Walnut Creek, CA.
A. E. Farrell, B. Michalczyk, and A. Nance.
Water Science and Technology WSTED4, Vol. 22, No. 12, p 75-83, 1990. 5 fig, 2 tab.

Descriptors: *Chlorinated hydrocarbons, *Dioxins, *Heavy metals, *Incineration, *Risk assessment, *Sludge disposal, *Waste management, California, Chemical wastewater treatment, Cost analysis, Environmental impact, Feasibility studies, Sludge stabilization.

The viability of continued sludge incineration at the Central Contra Costa Sanitary District (CCCSD: California) wastewater treatment plant was considered in a case study. A risk-based approach was employed to assess the long-term feasibility and cost of continued incineration compared other available sludge handling methods. Three major tasks were conducted as part of the study: an incinerator capacity evaluation, a risk assessment, and an evaluation of solids handling technol-

ogies. The study focused on toxics most often encountered in sewage incinerator emissions, including arsenic, beryllium, cadmium, chromium, lead, mercury, nickel, polychlorinated dibenzo-p-dioxins, and polychlorinated dibenzo-p-furans. The results of the study indicate that continued incineration of sludge is viable for the CCCSD, and the most cost-effective solids handling method is incineration using two duty units with backup provided by chemical stabilization. Pilot testing of chemical stabilization and indirect drying as backup methods is currently under way. (Author's abstract)
W91-08131

HEAVY METALS AND HEAT VALUE IN SEWAGE SLUDGE.
Mullheizkraftwerk Stadt und Landkreis Bamberg, Rheinstrasse 6, D-8600 Bamberg, FRG.
D. O. Reimann.
Water Science and Technology WSTED4, Vol. 22, No. 12, p 85-92, 1990. 2 fig, 2 tab, 12 ref.

Descriptors: *Caloric value, *Germany, *Heavy metals, *Sludge analysis, *Sludge disposal, *Sludge management, Air pollution, Design criteria, Flue gas cleaning, Incineration, Land disposal, Organic matter.

Of the 50 million tonnes of sewage sludge (5% dry solids) produced per year in the Federal Republic of Germany, 60% is dumped, 30% used in agriculture, and 10% is burned. For thermal treatment or disposal of sludge, knowledge of the salt and heavy metal content is important for the choice of the right flue gas cleaning system. Only by this means can hazardous emissions into the air be avoided. The advantage of sludge treatment vs dumping and utilization systems consists of the destruction of the organic pollutants. At the same time, a large portion of the heavy metals are evaporated by the high burning temperature and are entrained in the flue gas, from which they can be captured by condensation on the filter-ash or in the scrubber water. In the combustion of sludge the heat value is very important. It depends on the organic matter and water contents of the sludge, which can be influenced by dewatering systems. To achieve self-propagating incineration, a minimum caloric value in the sewage sludge of approximately 1000 kJoules/kg above the energy required for drying should be sought. If a mixture of substances such as sewage sludge and domestic refuse/coal or other high-calorie residue is incinerated rather than a single type of sewage sludge, the caloric value of the dewatered sewage sludge is less important. Domestic refuse typically has more heavy metals than sewage sludge. The levels of sulfur, phosphates, chlorides, and nitrogen may rise when sludge is mixed with fuels or waste products. Methods were developed for evaluating the significance of heavy metals in sewage sludge when considering the caloric value of a potential mixture. (Rochester-PTT)
W91-08132

SLUDGE MANAGEMENT AT THE MIDDLESEX COUNTY UTILITIES AUTHORITY.
Jacobs Environmental, Parlin, NJ.
A. Jacobs, and M. Silver.
Water Science and Technology WSTED4, Vol. 22, No. 12, p 93-106, 1990. 6 fig, 5 tab.

Descriptors: *New Jersey, *Ocean dumping, *Sludge drying, *Sludge management, *Sludge stabilization, *Waste management, Chemical wastewater treatment, Land reclamation, Landfills, Management planning, Pilot plants, Sludge disposal.

The Middlesex County Utilities Authority (MCUA, New Jersey) currently disposes of sewage sludge at a 106-mile site in the New York Bight (Atlantic Ocean). In accordance with New Jersey State law, the ocean disposal of sewage sludge must terminate on March 17, 1991. In 1988 the MCU initiated a land-based sludge management study to investigate the alternatives that are implementable by this deadline. Twenty-four alternatives were considered, each of which included dewatering and subsequent disposal/reuse. This study concluded that chemical fixation represents a cost-effective, environmentally responsible, implementable reuse alternative for MCUA sludge management. A pilot study was undertaken to evaluate chemical fixation of MCUA dewatered sludge. The program included constructing test plots at the MCUA-operated landfill and collecting and evaluating data on the physical, chemical, and biological properties. These analyses aimed to determine the acceptability of using chemically fixed MCUA sludge as a supplement to conventional soil for daily and intermediate landfill cover. Numerous properties of the sludge product in this use were examined, including physical properties, moisture content, leachate chemical constituents, burning characteristics, odor, and handling properties. In landfill cover use, the chemically fixed sludge satisfies the physical, biological, and chemical criteria for landfill cover as specified by the New Jersey Department of Environmental Protection. It was concluded that the material can be used as daily and intermediate cover. A facility for chemical fixation of the sludge prior to spreading has been designed to process 113 tons of dry solids/day in 1991, to increase to 134 tons/day by 2020. (Rochester-PTT)
W91-08133

LARGE-SCALE SEWAGE SLUDGE COMPOSTING: A CASE FOR MAINTAINING A DIVERSIFIED PROGRAM.
Philadelphia Water Dept., PA. Sludge Management Unit.
For primary bibliographic entry see Field 5D.
W91-08134

COMPACTION-GRANULATION PROCESS TURNS MUNICIPAL SLUDGE INTO A VALUABLE FERTILIZER COMPONENT.
Brown and Caldwell, Atlanta, GA.
For primary bibliographic entry see Field 5D.
W91-08147

CONTROL OF HEAVY METALS AND ORGANOCHLORINES USING THE OIL FROM SLUDGE PROCESS.
Enersludge (Australasia) Pty Ltd., Suite 93 Havelock Mall, West Perth, WA 6005, Australia.
For primary bibliographic entry see Field 5D.
W91-08148

IMPROVED EFFICIENCY OF SEWAGE SLUDGE INCINERATION BY PRECEDING SLUDGE DRYING.
Wupperverband, Wuppertal (Germany, F.R.).
H. Brechtel, and H. Eipper.
Water Science and Technology WSTED4, Vol. 22, No. 12, p 269-276, 1990. 8 fig, 1 tab, 5 ref.

Descriptors: *Incineration, *Sludge disposal, *Sludge drying, *Sludge management, Air pollution control, Caloric value, Energy management, Fluidized bed process, Germany, Odor control, Thin-film dryers, Wastewater treatment.

Normally, mechanical dewatering of sewage sludges is not sufficient for a self-supporting combustion, even if combustion is ensured in the fluidized bed furnace. The heat balance can be compensated by burning additional fuels of higher calorific value and by using the heat generated during combustion to pre-dry the sludge. The most favored solution is indirect drying in special equipment adapted to the state of the sewage sludge to be burned. Heating surfaces and the steam transfer the thermal energy of the flue gases to the mechanically dewatered sludge. The development of offensive odors and pollutant vapors is controlled by an appropriate process flow. The process entails not only an economy of primary energy, but an increase in furnace throughput. In Wuppertal-Buchenhofen, a fluidized-bed fired sludge incineration plant has been operating for 12 yr. At Wuppertal burning more wastes of higher calorific value is out of the question, so sludge drying has been employed as the only practical alternative. After tests, a horizontal thin-film dryer was chosen. Plans have been developed to employ thin-film drying of sludge prior to burning as a way to make the combustion process self-supporting, thus eliminating the need for auxiliary fuel. Vapor from sludge drying will not enter the furnace but will be condensed into the liquid sludge. Flue gas cleaning will be improved by extending existing electrostatic precipitators and reconstructing the flue gas scrubbers. It is expected that after reconstruction the throughput rate will be increased from 2.4 to 4.6 Mg/h per furnace line; light fuel oil and digester gas will no longer be needed as auxiliary fuel; and new tighter restrictions on emissions will be maintained. (Rochester-PTT)
W91-08150

POTENTIAL UTILIZATION OF SEWAGE SLUDGE.
National Univ. of Singapore. Dept. of Civil Engineering.
M. A. Aziz, and L. C. C. Koe.
Water Science and Technology WSTED4, Vol. 22, No. 12, p 277-285, 1990. 2 fig, 9 tab, 13 ref.

Descriptors: *Construction materials, *Singapore, *Sludge byproducts, *Sludge disposal, *Sludge management, *Sludge utilization, Ceramics, Concrete, Feasibility studies, Sludge drying, Soil amendments, Wastewater treatment.

Singapore is served by six modern sewage treatment plants with a combined design capacity of around 900,000 cu m/day. Currently 96.5% of the population is served by sewage systems and total production of raw sludge and digested dewatered sludge in 1988 was about 2,546,000 cu m and 39,000 cu m, respectively. Most of the dewatered sludge is used as a soil conditioner and landfilling. Feasibility studies were conducted on different ways of using dewatered sludge for producing building materials and other products and on its possible use as a soil conditioning additive or as a filler in concrete and bituminous mixes. Preliminary results of these investigations yielded the following conclusions: (1) sludge ash can be used directly or indirectly in construction; an example of direct usage include as an additive to improve the characteristics of subgrade soils for road construction; indirect usage includes as a raw material for producing concrete aggregates and in making various types of concrete and ceramic products such as tiles, bricks, paving blocks, drain sections, and pipes; and (2) production of various types of building materials from dewatered sewage sludge and the use of sewage sludge for improving soil properties, as well as its use as a filler material in concrete and bituminous mixes, could be a lucrative disposal alternative in the future. (Rochester-PTT)
W91-08151

SOLIDIFICATION OF ELECTROPLATING WASTEWATER TREATMENT SLUDGES WITH CEMENT.
Sao Paulo Univ. (Brazil). Escola Politecnica.
For primary bibliographic entry see Field 5D.
W91-08152

SLUDGE-AMENDED BRICK PRODUCTION: APPLICABILITY FOR METAL-LADEN RESIDUES.
Purdue Univ., Lafayette, IN. School of Civil Engineering.
J. E. Alleman, E. H. Bryan, T. A. Stumm, W. W. Marlow, and R. C. Hocevar.
Water Science and Technology WSTED4, Vol. 22, No. 12, p 309-317, 1990. 5 tab, 25 ref.

Descriptors: *Bricks, *Construction materials, *Metals, *Sludge disposal, *Sludge management, *Sludge utilization, Chemistry, Incineration, Leaching, Risk assessment, Vitrification, Weathering.

Few strategies exist for truly productive sludge use. In one singular process, however, the incorporation of sludge during brick manufacture might sterilize the sludge, combust its constitutive organics, and fuse the residue ash within a glassy matrix, ultimately yielding a highly attractive end product. Experiments were conducted on the general concept of using sludge in brick manufacture, with

specific emphasis on the fate of the metals contained within the sludge undergoing vitrification. Overall, it appears that most metals will be trapped within sludge-adulterated brick, both during firing and weathering. This behavior appears related to silicate-based physico-chemical containment mechanism. Volatilization of metal during firing was observed in the case of selenium, and in this instance only for specimens spiked with elevated metals levels (i.e., 1000 ppm Se). Simulated weathering in pH 2.5 and pH 5.0 acetic acid resulted in normal leachate losses beyond the United States Environmental Protection Agency extraction procedure limits for As, Se, and Cd. However, these marginally elevated losses were seen only for those bricks spiked with metals levels of 1000 ppm or higher. The research findings suggest that standard municipal sludges with 'normal' metal levels could be satisfactorily incorporated into a brick manufacturing process with little concern regarding metal releases. As for sludges laden with hazardous metals, brick manufacture may be an acceptable management option, although additional site-specific investigations may be necessary prior to implementation (e.g., relative to metal species, concentrations, and metal release characteristics). (Author's abstract)
W91-08154

MELTING SYSTEM FOR SEWAGE SLUDGE.
Kobek Steel Ltd., Kobe (Japan). Dept. of Environmental Equipment Engineering.
S. Oku, T. Kasai, M. Hiroaka, and N. Takeda.
Water Science and Technology WSTED4, Vol. 22, No. 12, p 319-327, 1990. 7 fig, 5 tab, 2 photo, 4 ref.

Descriptors: *Japan, *Melting, *Sludge disposal, *Sludge management, *Sludge utilization, Construction materials, Cooling rate, Energy use efficiency, Performance evaluation, Pilot plants, Slag, Sludge cake.

In Japan melting plants for sewage sludge are attracting great attention for their capability to produce molten slag and the possibility of its effective application. Several plants have commenced operation. A new sewage sludge melting system, melting after carbonizing sludge (MACS), was developed in which a swirling flow melting furnace is used. In 1987, a 50 t/day-scale demonstration furnace was installed and the technique has been demonstrated since then. The amount of heavy oil required to melt sludge in the plant is about 50 L/t of cake and the power is about 83 kWh/t of cake. Exhaust gas contains 20-30 ppm NOx (O2 12%), which is greatly below the 100-200 ppm typical of conventional fluidized bed incineration. Water-cooled slag forms fine amorphous particles. Possible applications include backfill and buried pipes. In rapidly cooled slag, x-ray diffraction showed that scarcely any crystallization occurs. Slowly cooled slag has a strength equivalent to natural stone and it has a wide variety of direct applications. (Rochester-PTT)
W91-08155

SEWAGE SLUDGE MELTING PROCESS: PRELIMINARY SYSTEM DESIGN AND FULL-SCALE PLANT STUDY.
Kyoto Univ. (Japan). Environment Preservation Center.
S. Sakai, M. Hiraoka, N. Takeda, and T. Tsunemi.
Water Science and Technology WSTED4, Vol. 22, No. 12, p 329-338, 1990. 5 fig, 2 tab, 8 ref.

Descriptors: *Energy use efficiency, *Japan, *Melting, *Sludge disposal, *Sludge management, *Sludge utilization, Comparison studies, Cost analysis, Incineration, Lime, Performance evaluation, Sludge conditioning.

A sewage sludge melting process has been developed and some full-scale plants are now installed or under construction in Japan. Full-scale operation results were obtained at the Chuo Plant, Osaka Prefecture, Japan, of the thermal pretreatment anaerobic digestion melting system. Energy balance and cost analyses were conducted. From the preliminary system design for 500,000 population capacity, the energy consumption was generally high in the lime conditioning system; systems including anaerobic digestion were advantageous over other systems in terms of energy balance; and energy input in the melting system was higher than that for the incineration system. Excess steam affected the comparative energy evaluation. As a result of cost analysis in terms of the annual treatment cost, it was revealed that the lime conditioning cost 50% more than the polymer conditioning; that in a comparison between the incineration and the melting systems, the treatment cost differed when the difference in energy cost was significant; and that in the anaerobic digestion systems, the superiority in energy balance did not contribute to treatment cost reduction. Even if, as one of the conditions for introducing the melting system to replace the incineration system, the ash disposal price is set as low as 5000 yen/t, the coke melting system is still advantageous in the lime conditioning. In polymer conditioning it was possible to establish conditions to introduce the melting system when the incinerated ash disposal price, the melting process coke ratio, and the coke price reached certain values. (Rochester-PTT)
W91-08156

MANAGEMENT OF SLUDGES FROM TREATMENT OF TOXIC WASTEWATERS.
Eckenfelder, Inc., Nashville, TN.
For primary bibliographic entry see Field 5D.
W91-08203

5F. Water Treatment and Quality Alteration

REMOVAL OF VOLATILE CONTAMINANTS FROM WATER BY ASPIRATION STRIPPING.
Pennsylvania State Univ., University Park. Dept. of Civil Engineering.
B. A. Dempsey, and J. Ackerman.
IN: Hazardous and Industrial Wastes: Proceedings of the 21st Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1989. p 135-145. 3 fig, 6 ref.

Descriptors: *Air stripping, *Volatile organic compounds, *Water treatment, Chlorinated hydrocarbons, Cost analysis, Groundwater, Radon.

Degreasing solvents, aromatic and aliphatic feedstocks, and radon are all volatile chemicals that are common contaminants of groundwater supplies and superfund sites. These volatile contaminants have relatively high Henry's constants and are therefore most conveniently and cheaply removed from water by extraction into air, often followed by further treatment of the contaminated air. Aspiration stripping was used for the removal of tetrachloroethylene from contaminated groundwaters that are used for drinking water. Aspiration stripping works well for the removal of volatile substances from water and the removal of volatile contaminants can be successfully predicted for a range of flows. Radon is more easily removed than tetrachloroethylene by aspirator strippers. Although capital costs for aspirator stripping are less than those for packed towers, the energy costs are presently higher than for packed towers or surface aerators. Aspirator strippers are simple in concept and practice and can be quickly installed, often without major construction activity, are relatively non-intrusive and have less visual and noise impact on a community than other technological solutions, and removal capacity can easily be staged. Whereas misting, freezing, decreased removal efficiencies with decreased temperature, and slime growth must be considered in the design and operation of alternative technologies, these issues seem unimportant for aspirator strippers. (See also W91-07139) (Mertz-PTT)
W91-07148

EFFECTS OF CHLORINE DIOXIDE ON REVERSE OSMOSIS MEMBRANES.
Olin Corp., New Haven, CT.
For primary bibliographic entry see Field 3A.
W91-07392

COAGULATION: REJUVENATION FOR A CLASSICAL PROCESS.
Georgia Inst. of Tech., Atlanta.
A. Amirtharajah.
Water Engineering and Management WENMD2, Vol. 137, No. 12, p 25-27, 32, December 1990. 1 fig.

Descriptors: *Coagulation, *Sedimentation, *Water treatment, Acidity, Alum, Color removal, Filtration, Flocculation, Humic substances, Hydrogen peroxide, Iron, Metals, Organic carbon, Ozone, Polymers, Reviews, Salts, Suspended solids, Turbidity.

Coagulation is a water treatment process by which small particles in the source water are transformed into large particles that can be removed by sedimentation. Some of the particles are disease-causing microorganisms, clay particles with attached humic substances, or humic substances associated with metals. The addition of coagulants causes destabilization and flocculation of the particles. Different chemical coagulants can cause the destabilization of suspensions in different ways. At this time combinations of inorganic salts (alum and iron), synthetic organic polymers (polyacrylamide, polydadmac), and polymeric inorganic coagulants (polyaluminum sulfate, polyaluminum chloride) and other oxidants (ozone, hydrogen peroxide) are, or will be, used in practice. Recent research has generated coagulation diagrams for predicting the chemical conditions under which coagulation occurs. These diagrams, which are generalizations, have been used to define the coagulant dosage and pH conditions for turbidity removal, color removal, and direct filtration. (Doria-PTT)
W91-07415

MAXIMIZE POLYMER ACTIVATION.
Stranco, Inc., Bradley, IL.
Y. Kim.
Water Engineering and Management WENMD2, Vol. 137, No. 12, p 28, 31, December 1990. 5 fig.

Descriptors: *Flocculation, *Polymers, *Water treatment, Hardness, Hydrogen ion concentration, Particulate matter, Residual chlorine, Temperature.

Many factors affect how readily polymeric flocculants can be fully activated. Recently, the effects of makeup water hardness, pH, and temperature on the activation of polymeric flocculants were investigated. Three acrylamide-based polymers with different ionicity were used. In general, maximum polymer activation can be encouraged by the use of soft water, temperatures under 40 C, a pH range of 4 to 9, water with minimal contaminants and particulates, and low level chlorine residuals. Operations lacking alternatives to the use of less desirable water can adjust for water characteristics in their polymer feed systems. (Doria-PTT)
W91-07416

ACID DEPOSITION: DRINKING WATER QUALITY AND HEALTH.
Welsh Water Authority, Powys.
For primary bibliographic entry see Field 5C.
W91-07481

DEVELOPMENT OF A PORTABLE DIRECT FILTRATION WATER TREATMENT PLANT IN NORTHERN MANITOBA.
Manitoba Hydro, Winnipeg.
D. L. Woytowich, and I. C. Goulter.
Canadian Journal of Civil Engineering CJCEB8, Vol. 17, No. 5, p 724-729, October 1990, 8 fig, 2 tab, 4 ref, French summary.

Descriptors: *Canada, *Filtration, *Manitoba, *Potable water, *Turbidity, *Water treatment, *Water treatment facilities, Construction, Hydroelectric plants, Nelson River, Pilot plants, Sundance, Water sources.

Part of the development of the Limestone Generating Project which was reactivated in 1985, was to review and implement potable water treatment fa-

cilities for the construction community of Sundance, if feasible. The source for the project would be the Nelson River which supplies water of reasonably good quality. However, turbidity ranges from 4 to 70 nephelometric turbidity units (NTU), averaging 15.2 NTU. A high rate, deep bed direct filtration system was proposed and constructed to reduce turbidity to acceptable levels following preliminary research and pilot plant studies. A key feature of the plant is its portability. Owing to the innovative design, the three filters can be easily transferred for use at future construction sites on the Nelson River. (Author's abstract)
W91-07523

AQUEDUCT AT CARTHAGE (L'AQUEDUC DE CARTHAGE).
Ecole Nationale des Ingenieurs de Tunis (Tunisia).
For primary bibliographic entry see Field 8A.
W91-07530

EXPERIMENTAL STUDIES ON CHLORINE DIOXIDE TREATMENT OF DRINKING WATER IN THE PRESENCE OF PHENOLIC COMPOUNDS AND 3,4-BENZPYRENE (UNTERSUCHUNGEN UND BETRACHTUNGEN ZUR FRAGE DER CHLORDIOXIDBEHANDLUNG VON TRINKWASSER BEI ANWESENHEIT VON PHENOLVERBINDINGEN UND 3,4-BENZPYREN).
Kreiskrankenhaus Treuenbrietzin (German D.R.).
H. Thielemann.
Zeitschrift fuer Wasser- und Abwasser-Forschung ZWABAQ, Vol. 23, No. 5, p 179-183, October 1990, 2 tab, 11 ref. English summary.

Descriptors: *Benzopyrene, *Chlorine dioxide, *Drinking water, *Organoleptic properties, *Phenolics, *Water treatment, Carcinogens, Chlorinated aromatic compounds, Chlorination, Odors, Polycyclic aromatic compounds, Taste.

Chlorine dioxide is preferable to chlorine for drinking-water treatment. When the water contains phenol, chlorine treatment results in the very unpleasant smell and taste of chlorophenol. Moreover, the chlorine dioxide method has the advantage of eliminating a great number of other taste substances. For example, with this method the water-treatment process does not produce 'taste indicators' caused by polycyclic aromatic hydrocarbons. Quantitative investigations of the removal of 3,4-benzopyrene by chlorine dioxide show that benzopyrene uptake increases logarithmically. Chlorine-dioxide treatment of drinking water containing 3,4-benzopyrene can therefore be regarded as a suitable means for eliminating the potential carcinogenic danger caused by elevated concentrations of dissolved polycyclics in water. The chlorine-dioxide method has gained in importance during the past few years. (King-PTT)
W91-07541

EVALUATING GAC FOR TRIHALOMETHANE CONTROL.
Southern California Metropolitan Water District, Los Angeles.
M. J. McGuire, M. K. Davis, C. H. Tate, E. M. Aieta, and E. W. Howe.
Journal of the American Works Association, JAWWA5, Vol. 81, No. 1, p 38-48, January 1991. 16 fig, 8 tab, 14 ref.

Descriptors: *Cost-benefit analysis, *Drinking water, *Granular activated carbon, *Trihalomethanes, *Water quality control, *Water treatment, Chloramines, Chlorine, Disinfection, Organic carbon, Safe Drinking Water Act, Synthetic organic compounds, Water quality standards.

The 1986 amendments to the Safe Drinking Water Act identify granular activated carbon (GAC) as a feasible treatment technique for synthetic organic chemicals, including trihalomethanes (THMs). A study was performed to optimize GAC treatment to meet more stringent THM standards, to estimate the costs of optimized GAC treatment, to identify by-products of the final disinfection of GAC-treated water, and to assess the ability of the rapid small-scale column test (RSSCT) to simulate total organic carbon (TOC) breakthrough from pilot-scale carbon contactors. The lowest THM concentration achievable by means of GAC treatment was found to be 10 micrograms/L. It was concluded that this type of treatment is expensive for the control of THMs, the predominant by-products of postdisinfection of GAC effluents with chlorine or chloramines. The RSSCT was shown to be an economical means of estimating pilot-scale TOC breakthrough, which can be used in making preliminary estimates of carbon utilization rates and cost estimates. (Author's abstract)
W91-07604

CONFERENCE SUMMARY: PRACTICAL ASPECTS OF THE DESIGN AND USE OF GAC.
American Water Works Association, Denver, CO.
J. L. Oxenford, and B. W. Lykins.
Journal of the American Water Works Association JAWWA5, Vol. 83, No. 1, p 58-64, January 1991. 1 tab.

Descriptors: *Conferences, *Drinking water, *Granular activated carbon, *Water treatment, Cost-benefit analysis, Design standards, Ohio, Volatile organic compounds, Water quality control, Water quality standards.

Reasons for the use of GAC include the fact that utilities need a barrier, such as GAC, for protection against potential organic contaminants, and the EPA has recommended GAC treatment as the best available technology for most volatile organic compounds and for several other contaminants. Some problems with GAC are difficulties with carbon handling, space limitations, short life of GAC for removing some compounds, high capital and operating costs, and disposal and regeneration costs. Alternative technologies are conventional treatment, powdered activated carbon (PAC), oxidation, aeration, synthetic adsorbents, and reverse osmosis. Predictive tools are useful in estimating the service time of GAC, and include pilot columns, small-scale columns, mass transfer models, and adsorption isotherms. It is important to know the design flow and to obtain a detailed water analysis, as well as the required removal efficiency. Potential problems associated with the design of an adsorption system are filling the carbon column to a desired level and maintaining it at that point, backwashing, removing the carbon, transport, and regeneration. The cost of a GAC system is greatly affected by economies of scale. Five case studies of experiences with GAC use in pilot or full-scale systems were Manchester (NH) Water Works; Pennsylvania-American Water Company; Suffolk County, NY; Metropolitan Water District (southern CA); and Cincinnati (OH) Water Works. Research continues to be conducted to develop more feasible treatment technologies. (Fish-PTT)
W91-07606

USING POWDERED ACTIVATED CARBON: A CRITICAL REVIEW.
Illinois Univ., Urbana.
I. N. Najm, V. L. Snoeyink, B. W. Lykins, and J. Q. Adams.
Journal of the American Water Works Association JAWWA5, Vol. 83, No. 1, p 65-76, January 1991. 1 fig, 12 tab, 74 ref.

Descriptors: *Activated carbon, *Organic pollutants, *Water treatment, Adsorption, Cost-benefit analysis, Performance evaluation, Powdered activated carbon, Synthetic organic compounds, Trihalomethanes, Water quality standards.

Synthetic and natural organic contaminants are often found in drinking water sources. The low removals of many undesirable compounds by coagulation, sedimentation, filtration, and chemical oxidation require that an adsorption process be used. Because the performance of powdered activated carbon (PAC) for uses other than taste and odor control is poorly documented, a critical review was made of uses that have been reported, and means of employing PAC more efficiently were analyzed. It was found that the extent of adsorption of synthetic organic chemicals on PAC is strongly dependent on the type of compound being removed. The reported removals of trihalomethanes and trihalomethane precursors by PAC range from poor to very good. In selecting the point of addition of PAC, consideration must be given to the degree of mixing, the contact time between the PAC and the water, the PAC residence time, and the minimization of interference of adsorption by treatment chemicals. One of the main advantages of PAC is its low capital cost. (Author's abstract)
W91-07607

PREDICTING GAC PERFORMANCE WITH RAPID SMALL-SCALE COLUMN TESTS.
Michigan Technological Univ., Houghton.
J. C. Crittenden, P. S. Reddy, H. Arora, J. Trynoski, and D. W. Hand.
Journal of the American Water Works Association JAWWA5, Vol. 83, No. 1, p 77-87, January 1991. 10 fig, 3 tab, 20 ref.

Descriptors: *Granular activated carbon, *Organic pollutants, *Performance evaluation, *Water treatment, Design standards, Dissolved organic carbon, Hydrocarbons, Particle size.

The rapid small-scale column test (RSSCT) is a scaled-down version of a pilot or full-scale granular activated carbon (GAC) column. Simple equations for selecting the design and operating parameters of RSSCTs from the full-scale process design variables have been developed, and their limitations examined. It is suggested that satisfactory RSSCT results can be obtained for one to three-carbon alkanes and alkenes and simple substituted ring structures using a constant diffusivity (CD) design and 60 x 80-mesh-size GAC. Particle sizes smaller than this mesh size using a CD design resulted in high head loss and poor results. Based on the testing of six raw-water sources, the success of small columns in predicting the breakthrough of dissolved organic carbon (DOC) in the pilot columns indicates that a proportional diffusivity (PD) design approach can be used in the design of full-scale systems as long as removal of DOC by biological growth is not important. Case studies representing high and low levels of synthetic organic chemicals, in the presence and absence of background dissolved organic carbon (DOC), and weakly and strongly adsorbing organics indicated that the RSSCT approach appears to be very useful, but the appropriate design for the RSSCT cannot be decided without at least one comparison with pilot data. (Fish-PTT)
W91-07608

MOBILIZATION OF GENETICALLY ENGINEERED PLASMID PHSV106 FROM ESCHERICHIA COLI HB101(PHSV106) TO ENTEROBACTER CLOACAE IN DRINKING WATER.
Delaware Univ., Newark. School of Life and Health Sciences.
C. H. Sandt, and D. S. Herson.
Applied and Environmental Microbiology AEMIDF, Vol. 57, No. 1, p 194-200, January 1991, 5 fig, 2 tab, 33 ref. USGS grant 14-08-0001-G1650.

Descriptors: *Culturing techniques, *Drinking water, *Genetic engineering, *Path of pollutants, *Water quality, DNA, Enterobacter, Escherichia coli, Microbiological studies, Plasmids.

Triparental matings were used to demonstrate transfer (mobilization) of nonconjugative genetically engineered plasmid pHSV106, which contains the thymidine kinase gene of herpes simplex virus cloned into pBR322, from Escherichia coli HB101 to an environmental isolate of Enterobacter cloacae in sterile drinking water. This is the first demonstration of a two-step mobilization of a genetically engineered plasmid in any type of freshwater, including drinking water. Transfer was mediated by R plasmid R100-1 of E. coli ED2149(R100-1). Matings in drinking water at 15, 25 and 35 C yielded recombinants, the number of which increased with increasing temperature. Numbers of recombinants obtained were 2 orders of magnitude lower than those obtained from matings in Trypticase soy broth. High concentrations of parental organisms 260 million to 2 billion CFU/ml) were

required. During 1 week of incubation in drinking water, numbers of parental organisms and recombinants resulting from mobilization remained constant in the absence of indigenous organisms and declined in their presence. Using oligonucleotide probes for the cloned foreign DNA (thymidine kinase gene) and plasmid vector DNA (ampicillin resistance gene), it was demonstrated that both genes were transferred to E. cloacae in the mobilization process. In one recombinant selected for detailed study, the plasmids containing these genes differed in size from all forms of pHSV106 present in E. coli HB101(pHSV106), indicating that DNA rearrangement had occurred. This recombinant maintained its plasmids in unchanged form for 15 days in drinking water. A second rearrangement occurred during serial passage of this recombinant on selective media. The possibility of rearrangements complicates risk assessment because antibiotic resistance gene DNA and cloned DNA can become dissociated, making foreign DNA more difficult to detect. (Author's abstract)
W91-07645

ASSAY FOR BETA-GLUCURONIDASE IN SPECIES OF GENUS ESCHERICHIA AND ITS APPLICATIONS FOR DRINKING-WATER ANALYSIS.
Environmental Protection Agency, Cincinnati, OH.
For primary bibliographic entry see Field 5A.
W91-07658

FEASIBILITY STUDIES FOR THE REMOVAL OF HEAVY METALS FROM SOLUTION USING TAILORED BENTONITE.
New Mexico State Univ., Las Cruces. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W91-07668

DROUGHT MANAGEMENT AND ITS IMPACT ON PUBLIC WATER SYSTEMS.
For primary bibliographic entry see Field 3D.
W91-07794

DIMENSIONS OF DROUGHT MANAGEMENT FOR PUBLIC WATER SUPPLIES.
Colorado Univ. at Boulder. Inst. of Behavioral Genetics.
For primary bibliographic entry see Field 3D.
W91-07795

WHAT ARE ACCEPTABLE RISKS FOR PUBLIC SYSTEMS.
Los Angeles City Dept. of Water and Power, CA.
For primary bibliographic entry see Field 3D.
W91-07797

DROUGHT MANAGEMENT OPTIONS.
Southern Illinois Univ., Carbondale. Dept. of Geography.
For primary bibliographic entry see Field 3D.
W91-07798

LEGAL AND INSTITUTIONAL ASPECTS OF DROUGHT MANAGEMENT.
Clyde and Pratt, Salt Lake City, UT.
For primary bibliographic entry see Field 3D.
W91-07799

EFFECT OF TEMPERATURE AND PH ON THE SETTLING BEHAVIOR OF A FLOCCULENT STRAIN OF ZYMOMONAS MOBILIS.
Universidade Federal de Pernambuco, Recife (Brazil). Dept. de Antibioticos.
For primary bibliographic entry see Field 5D.
W91-07853

SOFTENING BY MEANS OF ION EXCHANGE AND DECREASE OF CONTENT OF NEUTRAL SALT IN SURFACE WATERS (ENTHAERTUNG MIT IONENAUSTAUSCHERN UND VERMINDERUNG DES NEUTRALSALZGEHALTES IN OBERFLAECHENWAESSERN).
CKD, Prague (Czechoslovakia).
V. Kadlec, and P. Huebner.
Zeitschrift fuer Wasser- und Abwasser Forschung ZWABAQ, Vol. 23, No. 6, p 240-243, December 19904 fig, 5 tab, 8 ref. English summary.

Descriptors: *Chemical treatment, *Ion exchange, *Sodium chloride, *Wastewater treatment, *Water pollution control, *Water softening, *Water treatment, Chemical recovery, Electrolytes, Fluidized bed process, Hardness, Regeneration, Waste solidification.

Softening by means of ion exchange increases the content of neutral salts in receiving waters. A softening technique based on the principle of combined fluidized-bed and fixed-bed operation with an internal intensive backwash was developed which decreases the electrolyte content of wastewaters. The backwashing (with air and water simultaneously) can take place before each regeneration or periodically according to the degree of fouling of the resin layer. The results show a 30-40% sodium chloride saving for water with hardness between 1 and 5 mmol/L. For large plants with ion-exchange softening, NaCl recovery from regeneration waste by means of the lime/soda precipitation process is possible. In this way, soluble waste is replaced by solid waste. (King-PTT)
W91-07994

NOVEL N-HALAMINE DISINFECTANT COMPOUNDS.
Auburn Univ., AL. Dept. of Chemistry.
T. C. Tsao, D. E. Williams, C. G. Worley, and S. D. Worley.
Biotechnology Progress BIPRET, Vol. 7, No. 1, p 60-66, January/February 1991. 5 fig, 6 tab, 25 ref.

Descriptors: *Biocides, *Chemical treatment, *Disinfection, *Halogenated compounds, *Water treatment, Algicides, Bactericides, N-halamines, Sterilants, Swimming pools.

A new series of N-halamine compounds has been synthesized and tested for stability in aqueous solution and efficacy in inactivating several species of bacteria and algae. The compounds, which are N,N'-dihalo-4-immidazolidinones, are inexpensive to synthesize and appear to have considerable potential as general-purpose disinfectants. They have greater stability in the laboratory, as well as outdoors in direct sunlight, than do current commercial swimming pool biocides. They are also efficient at sterilizing hard surfaces (stainless steel) and could thus be useful for a variety of household and medical disinfection applications. (Author's abstract)
W91-08014

EFFECTS OF ACID PRECIPITATION RUNOFF EPISODES ON RESERVOIR AND TAPWATER QUALITY IN AN APPALACHIAN MOUNTAIN WATER SUPPLY.
Pennsylvania State Univ., University Park. Environmental Resources Research Inst.
For primary bibliographic entry see Field 5B.
W91-08025

EVALUATION OF MULTICOMPONENT ADSORPTION EQUILIBRIA FOR ORGANIC MIXTURES ONTO ACTIVATED CARBON.
Kuwait Univ., Safat. Dept. of Civil Engineering.
E. H. Smith.
Water Research WATRAG, Vol. 25, No. 2, p 125-134, February 1991. 8 fig, 3 tab, 17 ref. NSF Grant CES-8702786.

Descriptors: *Activated carbon, *Adsorption kinetics, *Organic compounds, *Water treatment, Chlorinated hydrocarbons, Equilibrium, Humic acids, Isotherms, Lindane, Model studies, Solutes.

Activated carbon adsorption isotherms were determined experimentally for mixtures containing specific synthetic organics and, in some instances, relatively uncharacterized background dissolved organic matter. Ideal adsorbed solution theory (IAST) was used to predict and/or describe competitive equilibria. Two models, the well-known Freundlich equation and an empirical three-parameter equation developed for this work, were used to describe single solute equilibria. As expected, the three-parameter model was able to describe more accurately single solute isotherms that deviated from log-log linearity. Comparisons were made of IAST calculations performed with the Freundlich versus the three-parameter equation and yielded mixed results, the interpretation of which may be influenced by the method chosen to quantify the goodness of fit. The systems studied also exhibited variability in the degree of ideality with respect to solute-solute competition as evaluated by IAST. A modeling methodology that evaluated equilibrium parameters and modeled data in terms of the target compounds only provided a quantitative assessment of the impacts of unknown organic background on the adsorption capacity of the target species. (Author's abstract)
W91-08046

EFFECTS OF PREOZONATION ON THE ADSORBABILITY AND THE BIODEGRADABILITY OF AQUATIC HUMIC SUBSTANCES AND ON THE PERFORMANCE OF GRANULAR ACTIVATED CARBON FILTERS (INFLUENCE D'UNE PREOZONATION SUR L'ADSORBABILITE ET LA BIODEGRADABILITE DES SUBSTANCES HUMIQUES D'ORIGINE AQUATIQUE ET SUR LES PERFORMANCES DES FILTRES DE CHARBON ACTIF EN GRAINS).
Poitiers Univ. (France). Lab. de Chimie de l'Eau et des Nuisances.
J. De Laat, M. Dore, and J. Mallevialle.
Water Research WATRAG, Vol. 25, No. 2, p 151-164, February 1991. 10 fig, 7 tab, 34 ref. English summary.

Descriptors: *Activated carbon, *Adsorption, *Biodegradation, *Fulvic acids, *Humic acids, *Ozonation, *Water treatment, Dissolved organic carbon, Drinking water, Filtration, France, Humic substances, Isotherms, Ozone.

The effects of ozonation on the biodegradability of humic substances and on the performance of granular activated carbon (GAC) columns were investigated using humic and fulvic acids from Pinail, a nature reserve near Poitiers (France). Ozonation of humic and fulvic acids led to a much larger removal of ultraviolet absorbance compared with the removal of dissolved organic carbon (DOC). Preozonation significantly improved the biodegradability of humic substances. For a high ozone dose (2 mg O3/mg C), 40-45% of the residual DOC after ozonation was biodegraded after a 28-day incubation. Adsorption isotherms and the Freundlich constants clearly showed a decrease in adsorbability of DOC with increasing preozonation doses. GAC filtrations operated in parallel, under both sterile and nonsterile conditions, allowed differentiation between biological and adsorptive DOC removal and showed the effect of an ozone preoxidation dose of 0.5 mg O3/mg C on the performance of GAC filters. Fulvic acid was removed only by an adsorption mechanism in GAC columns. A preozonation treatment prior to GAC filtration improved the biodegradability of fulvic acid and consequently enhanced the performance of GAC filters. DOC and inorganic carbon analyses indicated that biodegradation was responsible for an average of 8-10% of the DOC removal in the nonsterile column that received ozonated Pinail fulvic acid. (Doria-PTT)
W91-08049

SIMPLE COMBINATION OF BIODEGRADATION AND CARBON ADSORPTION: THE MECHANISM OF THE BIOLOGICAL ACTIVATED CARBON PROCESS.
Tsinghua Univ., Beijing (China). Dept. of Environmental Engineering.
For primary bibliographic entry see Field 5D.
W91-08050

EFFECTS OF OZONATION AND ACTIVATED CARBON ADSORPTION ON TRIHALOMETHANE SPECIATION.

Colorado Univ. at Boulder. Dept. of Civil, Environmental, and Architectural Engineering.
G. L. Amy, L. Tan, and M. K. Davis.
Water Research WATRAG, Vol. 25, No. 2, p 191-202, February 1991. 15 fig, 5 tab, 16 ref.

Descriptors: *Activated carbon, *Ozonation, *Trihalomethanes, *Water treatment, Adsorption, Brominated hydrocarbons, Bromine, Dissolved organic carbon, Fate of pollutants, Oxidation.

Two surface water sources in the southwestern United States were studied in bench-scale experiments examining two trihalomethane (THM) precursor removal processes, activated carbon adsorption and ozone oxidation. Both source waters contained bromide, leading to brominated THMs upon chlorination. Activated carbon removed THM precursors, as measured by dissolved organic carbon (DOC), while having little effect on bromide. The net result was an increase in the ratio of Br(-)/DOC and an increase in the relative abundance of brominated THMs. Ozone oxidized higher molecular weight precursor molecules into lower molecular weight by-products which were less reactive with chlorine. Moreover, ozonation appeared to transform Br(-) to hypobromous acid (an in situ oxidant), leading to an increase in the percentage of brominated THMs. (Author's abstract)
W91-08054

TRIHALOMETHANE ADSORPTION ON ACTIVATED CARBON FIBERS.
Tokyo Univ. (Japan). Inst. of Industrial Science.
Sadoka, M. Suzuki, R. Hirai, and K. Kawazoe.
Water Research WATRAG, Vol. 25, No. 2, p 219-225, February 1991. 9 fig, 2 tab, 13 ref.

Descriptors: *Activated carbon, *Adsorption, *Trihalomethanes, *Water treatment, Chloroform, Comparison studies, Drinking water, Isotherms, Mathematical models.

Adsorption isotherms of three trihalomethanes (THMs) involving CHCl3, CHBrCl2, and ChBr2Cl on activated carbon fibers (ACFs) were measured. Adsorption capacities of the ACFs for these THMs were found to be comparable with or slightly larger than those of granular activated carbons (GACs) which have been widely used for trihalomethane control in drinking water. Also, the breakthrough curve prediction was successfully carried out using a mathematical model on the basis of the assumption that the adsorption equilibrium is instantaneously established when a THM solution contacts the ACF. In practice, THM removal from drinking water was investigated at water works using bench-scale ACF adsorption columns. The volume of water treated at a space velocity of about 100/h was approximately 40 L/(g-ACF) (Author's abstract)
W91-08057

REGENERATION BY SURFACE-COATING OF BONE CHAR USED FOR DEFLUORIDATION OF WATER.
Panum Inst., Copenhagen (Denmark).
J. Christoffersen, M. R. Christoffersen, R. Larsen, and I. J. Moller.
Water Research WATRAG, Vol. 25, No. 2, p 227-229, February 1991. 1 tab, 3 ref. WHO Grant ORH D2/180/2.

Descriptors: *Char, *Fluorides, *Water treatment, Bone char, Calcium chloride, Hydrochloric acid, Hydrogen ion concentration, Phosphates, Regeneration.

A bone char column used to defluoridate water can be very simply and repeatedly regenerated without significant loss of binding capacity for fluoride or of efficiency. The regenerating solution contains calcium chloride and sodium dihydrogen phosphate with pH adjusted to about 3. The regenerating solution can also be produced by dissolving the present waste part of the bone char product, which is too finely powderized for use in the column, in dilute hydrochloric acid. During regeneration, most of the pre-adsorbed fluoride is retained by the bone char and the precipitating phase is apatitic. The 'regeneration' is thus a surface-coating process. (Author's abstract)
W91-08058

FINGERPRINTING OF COMMERCIALLY AVAILABLE WATER TREATMENT BACTERICIDES IN SOUTH AFRICA.
Pretoria Univ. (South Africa). Dept. of Microbiology and Plant Pathology.
V. S. Brozel, and T. E. Cloete.
Water SA WASADV, Vol. 17, No. 1, p 57-66, January 1991. 5 fig, 4 tab, 19 ref.

Descriptors: *Bactericides, *Cooling water, *Disinfection, *South Africa, *Water treatment, Carbamate pesticides, Comparison studies, Cost analysis, Pesticides.

Eighteen dominant isolates from water-cooling systems in South Africa were exposed to 50 mg/L of commercially available bactericides, and the kill percentage was determined after 6 h. Application costs of all bactericides giving an average kill percentage of over 90% were compared. Low-cost bactericides were re-evaluated at cost-equivalent concentrations. Dichlorophen, sulphone, a thiocarbamate, and biphenol performed best, killing the full spectrum of isolates cost-effectively. Certain expensive products performed rather poorly, including isothiazoline and MBT. This study highlights the selective action of many bactericides and the inherent resistance of bacteria to a number of different bactericides. This implies the importance of matching bactericides to the dominant bacteria in systems. (Author's abstract)
W91-08093

HEALTH HAZARDS OF NITRATE IN DRINKING WATER.
Research Inst. for Environmental Diseases, Pretoria (South Africa).
For primary bibliographic entry see Field 5C.
W91-08095

INDUCTION OF GASTROINTESTINAL TRACT NUCLEAR ANOMALIES IN B6C3F1 MICE BY 3-CHLORO-4-(DICHLOROMETHYL)-5-HYDROXY-2(5H)-FURANONE AND 3,4-(DICHLORO)-5-HYDROXY-2(5H)-FURANONE, MUTAGENIC BYPRODUCTS OF CHLORINE DISINFECTION.
Health Effects Research Lab., Cincinnati, OH.
F. B. Daniel, G. R. Olson, and J. A. Stober.
Environmental and Molecular Mutagenesis EMMUEG, Vol. 17, No. 1, p 32-39, 1991. 2 fig, 3 tab, 42 ref.

Descriptors: *Bioassay, *Byproducts, *Chlorinated hydrocarbons, *Chlorination, *Disinfection, *Drinking water, *Furanones, *Mutagenicity, *Water treatment, Animal pathology, Animal tissues, Degradation products, Gastrointestinal tract, Mutagens, Path of pollutants, Toxicity.

Two chlorinated hydroxylated furanones, 3-chloro-4-(dichloromethyl)-5-hydroxy-2(5H)-furanone (MX) and 3,4-dichloro-5-hydroxy-2(5H)-furanone (MA) are bacterial mutagens. They are also byproducts of chlorine disinfection, and frequent contaminants of drinking water. Groups of male B6C3F1 mice were given a single oral dose of 0.1 to 0.46 mmol/kg MX or 0.23 to 0.47 mmol/kg MA. MX induced nuclear anomalies in the gastrointestinal tract of the B6C3F1 mouse. The other chlorohydroxy furanone, MA, gaves suggestive evidence of activity. The duodenum was the most sensitive tissue, responding with both increased numbers of nuclear anomalies per mouse and increased incidence of animals presenting the nuclear aberrations 24 hours after a single oral dose of 0.37 mmol/kg of MX. MA also induced a significant increase in duodenal nuclear anomalies, but only at the highest dose (0.46 mmol/kg). The proximal colon and forestomach responded to MX but not to MA. MX was approximately equivalent in potency to epichlorohydrin (ECH) but was much less potent than methyl nitrosourea (MNU). The latter two chemicals are confirmed rodent gastrointestinal tract carcinogens. This is the first study demonstrating that chlorohydroxy furanones are capable of inducing nuclear toxicity in vivo. However, it is clear, for MX at least, that its potency in the gastrointestinal tract nuclear anomalies assay is not commensurate with its extreme bacterial mutagenicity. Since the gastrointestinal tract tissues are directly exposed to orally administered genotoxins, one possible explanation for the weak response observed in this study could be that mammalian cells can effectively detoxify chlorohydroxy furanones. (Author's abstract)
W91-08175

RECENT METHODS FOR THE DETERMINATION OF VOLATILE AND NON-VOLATILE ORGANIC COMPOUNDS IN NATURAL AND PURIFIED DRINKING WATER.
Centre de Recherche Lyonnaise des Eaux - Degremont, Le Pecq (France).
For primary bibliographic entry see Field 5A.
W91-08177

GAS CHROMATOGRAPHIC-MASS SPECTROMETRIC CHARACTERIZATION OF VOLATILE ORGANIC COMPOUNDS IN BARCELONA TAP WATER.
Institut d'Estudis Catalans, Barcelona (Spain).
A. Guardiola, F. Ventura, L. Matia, J. Caixach, and J. Rivera.
Journal of Chromatography. Biomedical Applications JCBADL, Vol. 562, p 481-492, 1991. 4 fig, 3 tab, 27 ref.

Descriptors: *Barcelona, *Chromatography, *Drinking water, *Gas chromatography, *Mass spectrometry, *Pollutant identification, *Stream pollution, *Volatile organic compounds, *Water analysis, Chemical analysis, Industrial wastes, Llobregat River, Organic pollutants, Reservoirs, Rivers, Separation techniques, Spain, Stream profiles, Ter River, Water pollution sources, Water quality.

Barcelona's tap water is supplied by the Llobregat and Ter rivers which have significant differences in raw water quality. The Llobregat river is extremely polluted, bearing effluents from various industries including textile, salt works, surfactants and domestic wastewaters. The Ter river receives effluents from textile and tannery industries before reaching a three-reservoir system. Volatile organic compounds (VOCs) from Barcelona tap water were isolated by closed-loop stripping analysis (CLSA) and identified by gas chromatography-mass spectrometry. Results from analysis of samples collected weekly from September 1989 to March 1990 showed that the Ter river gives the better quality tap water. VOCs, in particular solvents, phosphates, hydrocarbons, C3 and C4 alkylbenzenes and surfactant-related compounds such as C10 to C13 alkylbenzenes and nonionic compounds such as polyethoxylated nonylphenols and their brominated derivatives are present at the ppb level. The last two types of compounds have not previously been reported using the CLSA technique. While water quality of raw water entering the water works plant on the Llobregat river is clearly influenced by spills of extremely diverse origin, tap water from the Ter river is less influenced by spills because the three-reservoir system acts as a barrier for the transport of pollutants. Thus, tap water from the Ter river showed similar profiles throughout the study. (Author's abstract)
W91-08178

5G. Water Quality Control

ENHANCED BIODEGRADATION OF PESTICIDES IN THE ENVIRONMENT.
Developed from a symposium held in Miami Beach, Florida, September 10-15, 1989. American Chemical Society, Washington, DC. 1990. 302p. Edited by Kenneth D. Racke and Joel R. Coats.

Descriptors: *Agricultural chemicals, *Biodegradation, *Cleanup, *Fate of pollutants, *Microbial degradation, *Microorganisms, *Pesticides, *Soil chemistry, *Water pollution treatment, Adaptation, Aquatic environment, Environmental quality,

Fungicides, Herbicides, Insecticides, Management planning.

Microbial degradation has long been recognized as a primary means of dissipating many pesticides in soil and water ecosystems, a recognition of this has prompted the development of biodegradable herbicides, insecticides, and fungicides. Early research on the degradation of phenoxy herbicides in soil provided evidence that microbial adaptation could result in abnormally accelerated rates of pesticide breakdown. The contemporary occurrence of enhanced degradation and associated pest control failures has spurred reexamination of adapted microbial pesticide degradation as a critical environmental process. Therefore the adaptation of microorganisms for rapid pesticide degradation was studied. Three aspects of degradation were addressed: (1) field and laboratory observations of enhanced herbicide, insecticide, and fungicide degradation; (2) the micorbiological and biochemical aspects of adapted microbial pesticide metabolism in terrestial and aquatic systems; and (3) management strategies and implications of enhanced pesticide degradation. These studies have spanned disciplines ranging from applied agronomy to molecular biology. (See W91-07119 thru W91-07138) (MacKeen-PTT)
W91-07118

ADAPTATION OF MICROORGANISMS IN SUBSURFACE ENVIRONMENTS: SIGNIFICANCE TO PESTICIDE DEGRADATION.
Agricultural Research Service, Stoneville, MS. Southern Weed Science Lab.
T. B. Moorman.
IN: Enhanced Biodegradation of Pesticides in the Environment. ACS Symposium Series 426. American Chemical Society, Washington, DC. 1990. p 167-180. 4 fig, 1 tab, 60 ref.

Descriptors: *Agricultural chemicals, *Aquifers, *Biodegradation, *Bioremediation, *Fate of pollutants, *Groundwater pollution, *Microorganisms, *Pesticides, Adaptation, Literature review, Metabolism, Microbial degradation, Soil bacteria.

A review of factors affecting the adaptation of microorganisms to pesticide degradation in subsurface environments is presented. The degradation of pesticides in subsurface soils and aquifer environments proceeds at relatively slow rates. The lack of adaptation to pesticides in the subsurface environment may be due to both physiological and environmental constraints. Adaptation of microorganisms to pesticides in surface soils is a process that includes examples of population growth and enzyme induction as contributing factors. Introduced microbial agents have some potential for detoxification of pesticides in groundwater, but the low level of nutrients in aquifers contaminated with trace levels of pesticides limits microbial activity and may reduce the effectiveness of introduced microorganisms. (See also W91-07118) (Author's abstract)
W91-07131

ENHANCING BIODEGRADATION FOR DETOXIFICATION OF HERBICIDE WASTE IN SOIL.
Illinois Natural History Survey, Champaign. Center for Economic Entomology.
A. S. Felsot, and E. K. Dzantor.
IN: Enhanced Biodegradation of Pesticides in the Environment. ACS Symposium Series 426. American Chemical Society, Washington, DC. 1990. p 249-268. 2 fig, 6 tab, 48 ref. Illinois Hazardous Waste Research and Information Center Project HWR 88-042.

Descriptors: *Alachlor, *Biodegradation, *Cleanup operations, *Microbial degradation, *Microorganisms, *Pesticides, *Soil contamination, Adaptation, Agricultural chemicals, Fungi, Herbicides, Metabolism, Soil bacteria, Soil environment, Wastes.

Pesticides in soil at high concentrations have been found to be unusually resistant to normal biodegradative processes. Microbial systems have been proposed as cost effective techniques suitable for cleanup of pesticide waste. In an attempt to enhance the detoxification in soil of high concentrations of the herbicide alachlor, experiments were designed to test the effects of several factors on alachlor persistence: soil dilution, concentration, formulation, nutrient amendments, and microbial inoculation. Alachlor in soil from a waste site degraded faster when diluted with uncontaminated soil by 90% than when diluted by 10 or 50%. Alachlor was metabolized into water-soluble compounds in soil at a concentration of 10 ppm but not at 1000 ppm. Amendment of soil with ground corn or soybean stubble stimulated the biodegradation of alachlor at a concentration of 100 ppm but not at 1000 ppm. When alachlor was present as a sole carbon source, several bacterial isolates partially detoxified concentrations of 10 ppm but not 100 ppm. Fungal isolates could cometabolically degrade 100 ppm alachlor in pure culture; however, inoculation of soil with an alachlor-degrading fungus alone did not enhance degradation. (See also W91-07118) (Author's abstract)
W91-07137

HAZARDOUS AND INDUSTRIAL WASTES: PROCEEDINGS OF THE 21ST MID-ATLANTIC INDUSTRIAL WASTE CONFERENCE.
For primary bibliographic entry see Field 5D.
W91-07139

HAZARDOUS WASTE MINIMIZATION MEASURES IMPLEMENTED BY METAL-PLATING PLANTS IN THE SAN FRANCISCO BAY AREA.
Stanford Univ., CA. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W91-07144

WASTE MINIMIZATION: CASE STUDY.
BCM Engineers, Inc., Plymouth Meeting, PA.
For primary bibliographic entry see Field 5D.
W91-07145

RECYCLING OF BY-PRODUCT GYPSUM.
Pennsylvania State Univ., University Park.
For primary bibliographic entry see Field 5D.
W91-07146

CLEAN COAL TECHNOLOGY WASTE CHARACTERIZATION.
Argonne National Lab., IL. Energy and Environmental Systems Div.
For primary bibliographic entry see Field 5D.
W91-07147

BIODEGRADATION OF PETROLEUM CONTAMINANTS IN SOIL.
O'Brien and Gere Engineers, Inc., Blue Bell, PA.
D. M. Magazu, and J. Carberry.
IN: Hazardous and Industrial Wastes: Proceedings of the 21st Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1989. p 207-212. 4 fig.

Descriptors: *Biodegradation, *Cleanup, *Hydrocarbons, *Oil pollution, *Soil contamination, *Soil treatment, *Water pollution treatment, Biological treatment, Chemical oxygen demand, Desorption, Oxygen, Rehabilitation, Storage tanks.

The contamination of soil surrounding leaking underground storage tanks poses a direct threat to the immediate community and the groundwater table below the storage tank. Remediation techniques utilized to remove petroleum contamination from soil have been limited to ventilation (or vapor extraction), soil excavation and land filling, and biodegradation. Biodegradation of petroleum contamination by indigenous microorganisms provides the potential for permanent, economical remediation. The other techniques provide only short-term or incomplete removal of the petroleum contamination. The optimum environmental conditions for the biodegradation of petroleum contaminants in soil were determined. The soils sampled and used for the investigation were from five sites contaminated with petroleum hydrocarbons. Petroleum contaminants consisted of kerosene, No. 2 fuel oil, toluene, and two types of unleaded gasoline. Testing conditions consisted of: (1) nutrient supplementation; (2) nutrient and oxygen supplementation; (3) nutrient, oxygen and microbial (1.0 ml) supplementation; (4) nutrient, oxygen and microbial (2.0 ml) supplementation; and (5) nutrient, oxygen, and microbial (5.0 ml) supplementation. Chemical oxygen demand was used as a measure of the hydrocarbon present in the reactor. By monitoring the chemical oxygen demand of the reactor containing distilled water (control), the desorption curve was observed. Chemical oxygen demand steadily increased, suggesting a continuous desorption of hydrocarbons from the soil particles. All five hydrocarbons tested displayed linear desorption curves. This desorption curve represented the available hydrocarbon to the microorganisms. (See also W91-07139) (Mertz-PTT)
W91-07153

DEVELOPMENT OF PENNSYLVANIA ENVIRONMENTAL POLICY AND OPPORTUNITIES FOR IMPACT.
D. E. Skoff, B. J. Hill, and G. G. McGee.
IN: Hazardous and Industrial Wastes: Proceedings of the 21st Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1989. p 389-408. 4 fig, 7 ref.

Descriptors: *Environmental law, *Pennsylvania, *Waste disposal, *Water pollution control, Environmental impact, Environmental policy, Hazardous wastes, Organizations, Radioactive wastes, Recycling, Regulations.

The recent flurry of environmental regulations and legislation in Pennsylvania has significantly changed Pennsylvania's environmental policy. Major changes include passage of the Municipal Waste Planning, Waste Reduction, and Recycling Act that makes counties responsible for waste planning and management, the Hazardous Sites Cleanup Act that establishes a state Superfund program patterned after the federal program, and the Low-level Radioactive Waste Disposal Act that establishes siting procedures for the Appalachian States Compact's low-level radioactive waste disposal facility in Pennsylvania. New municipal waste and construction/demolition landfill regulations were promulgated in 1988, and new residual waste regulations are pending. The legislative and regulatory processes that contribute to the development of Pennsylvania environmental policy offer many opportunities for public participation. Individuals or organizations can affect state policy either formally by testifying at public hearings and submitting written comments or informally by meeting with and writing letters to key groups and individuals involved in the process. At times, it is wise to utilize existing groups because they have the resources and knowledge necessary to affect the final form of legislation and regulations. Organizations such as the Pennsylvania Sierra Club, the Pennsylvania Manufacturers Association, the Pennsylvania Chamber of Business and Industry, the League of Women Voters, and the Pennsylvania Environmental Council have programs in place to identify the interests of their members, research environmental issues, develop positions on pending legislation, and promote their positions. All of these organizations played some part in shaping the environmental legislation and regulations passed in 1988. (See also W91-07139) (Mertz-PTT)
W91-07167

POLICY ANALYSIS OF ALBERTA'S HAZARDOUS WASTE MANAGEMENT PROGRAM -- A RESEARCH PERSPECTIVE.
Alberta Special Waste Management Corp., Edmonton.
C. Zeiss.
IN: Hazardous and Industrial Wastes: Proceedings of the 21st Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1989. p 409-422. 4 fig, 1 tab, 12 ref.

Descriptors: *Alberta, *Canada, *Environmental law, *Hazardous waste disposal, *Waste disposal, *Waste management, *Water pollution control,

Environmental impact, Environmental quality, Hazardous wastes, Industrial wastes, Legal aspects.

Alberta, Canada's integrated hazardous waste management program consists of a new central treatment facility, a waste collection system, and new regulations and enforcement policies. The construction of a new integrated hazardous waste disposal facility and the adoption of strict hazardous waste regulations and enforcement policies require changes in waste management procedures and usually result in higher costs to waste generators. As a result, manufacturing investment and activity may decline, while waste minimization and on-site treatment may decrease and change the waste stream delivered to the disposal facility, thereby negatively affecting plant economics. This could affect environmental quality near waste generators' sites. If these expected results are borne out, several policy options should be considered. Changes in economic development policy are probably not needed because the extra costs for waste management are small, and are probably offset by the capability to adequately dispose of waste at a central facility. This also eliminates long-term liability for waste disposal. The decrease in waste volumes after the initial push to eliminate inventories results in the dilemma of either having too small a plant to dispose of the wastes or too much capacity in the long-term. Similarly, the treatment methods may become obsolete or inappropriate due to the shift to lower heat-value, more concentrated waste streams. Initially, rigorous enforcement efforts are needed, especially for less conspicuous, small generators. However, fairness in terms of cost and ease of dealing with regulatory agencies may be more persuasive. Small firms can be audited in clusters to fairly treat all generators in a community. (See also W91-07139) (Mertz-PTT)
W91-07168

SEEKING ORDER WITHIN THE CHAOS OF TOXICS LAWS: THE TOXICS PROGRAM MATRICES IN NEW JERSEY AND PENNSYLVANIA.

ENSCO Environmental Services, Inc., Fremont, CA.
J. F. Elliot, and W. P. Parkin.

IN: Hazardous and Industrial Wastes: Proceedings of the 21st Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1989. p 423-432.

Descriptors: *Environmental law, *Hazardous wastes, *New Jersey, *Pennsylvania, *Toxic wastes, *Waste disposal, *Water pollution control, Environmental protection, Industrial wastes, Legal aspects, Regulations, Water law.

Regulation of toxic compounds comes from many sources. New Jersey and Pennsylvania are good examples of the mountains of toxics rules and regulations enacted over the last decade. Early regulation of toxics came with the federal Clean Air Act of 1970 and 1977, the Federal Water Pollution Control Act of 1972 and the Clean Water Act of 1977. The Resource Conservation and Recovery Act of 1976 (RCRA) created cradle to grave management of hazardous wastes. In addition to federal regulations, the toxics program matrix in New Jersey includes hazardous materials control programs implemented by the Occupational Safety and Health Administration, the New Jersey Department of Environmental Protection, the federal Department of Health, the New Jersey Department of Labor, the U.S. EPA, the New Jersey Department of Health, and the Bureau of Fire Safety. The U.S. EPA and the New Jersey Department of Environmental Protection share many aspects of hazardous waste regulation. Many other toxic laws and programs stem from these two regulatory bodies, but may come under air regulations, water regulations, pesticide laws or waste disposal rules. Pennsylvania offers a similarly difficult maze of toxics laws. Programs may be implemented by the Department of Environmental Resources, the Department of Labor and Industry, as well as local authorities. Much attention has focused on specific hazardous substances. Lists of these materials exist as Hazardous Air Pollutants, Criteria Pollutants, Hazardous Wastes and Extremely Hazardous Wastes, or the Extremely Hazardous Substances list, with each of these lists accompanying a different law or act. Most toxics laws are appended onto the functions and programs of traditional health, safety and environmental protection agencies. Implementors of environmental programs are often frustrated by the fragmented requirements. A more practical approach is needed. Coordination and cooperation among individual companies and agencies should be increased. (See also W91-07139) (Mertz-PTT)
W91-07169

UTILITY OF EMPLOYING MATHEMATICAL MODELS IN REGULATING GROUNDWATER PROTECTION.

J. J. McKeown, K. Norvig, and M. Arnold.

IN: Hazardous and Industrial Wastes: Proceedings of the 21st Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1989. p 435-458. 1 fig, 11 tab, 20 ref.

Descriptors: *Computer models, *Fate of pollutants, *Groundwater pollution, *Model studies, *Path of pollutants, *Water pollution control, *Water pollution prevention, Groundwater potential, Groundwater transport, Groundwater use, Legal aspects, Mathematical models, Pennsylvania, Water law.

Fate and transport modeling has traditionally been used by engineers and scientists in developing remedies to remove contaminants from groundwater. For example, such modeling has aided in determining well placement and duration of pumping for removing contaminants from groundwater in addition to assessing the need to remove or treat soils for removal of specific chemicals. Such models have been successfully employed for site specific situations. Although models are specific to particular space and time domains, their recent use in regulations, both Federal and State, to characterize solid wastes is note worthy. The EPA's definition of hazardous wastes for a large group of organic chemicals and Pennsylvania's use of the cation exchange capacity of soil to characterize wastes for appropriate containment scenarios are representative of how agencies are beginning to utilize mathematical models in regulation. The EPA has set a precedent. Industry has developed and adapted fate and transport modeling for designing facilities and demonstrating compliance. Pennsylvania has proposed regulations incorporating modeling. (See also W91-07139) (Mertz-PTT)
W91-07170

EVALUATING GROUNDWATER REMEDIATION WITH GROUNDWATER MODELING.

Dunn Geoscience Corp., Albany, NY.
W. J. Miller, P. W. Hare, and M. E. Lawler.

IN: Hazardous and Industrial Wastes: Proceedings of the 21st Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1989. p 459-473. 7 fig, 2 ref.

Descriptors: *Cleanup, *Groundwater quality, *Hazardous wastes, *Model studies, *Path of pollutants, *Rehabilitation, *Site remediation, *Superfund, Delaware, Environmental impact, Environmental monitoring, Environmental policy, Groundwater management, Groundwater movement, Groundwater pollution, Industrial wastes.

In response to the Superfund Amendments and Reauthorization Act (SARA) and the National Oil and Hazardous Substances Contigency Plan (NCP), a detailed analysis of potential remedial alternatives is required before remediating abandoned hazardous waste sites. For sites with groundwater contamination, the analysis of remedial alternatives frequently employs groundwater modeling. Modeling contributes to the technical evaluation and helps determine environmental impacts of selected remedial alternatives. It also provides a means to directly compare the effectiveness of different groundwater remediation scenarios. Such an application is exemplified in the Feasibility Study for the Delaware Sand and Gravel Landfill where groundwater modeling was used to evaluate plume fate and the operation of existing recovery wells in a complex sequence of Pleistocene and Cretaceous sediments of the Atlantic Coastal Plain. The hydrogeologic system modeled was complicated by the existence of several industrial and public supply well fields in proximity to Delaware Sand and Gravel and by the existence of another landfill immediately adjacent to Delaware Sand and Gravel. Model results indicated additional recovery wells were not necessary to control contamination emanating from the Delaware Sand and Gravel landfill; however, source control measures for removal of inorganic and volatile organic contamination would be necessary to meet SARA goals and criteria. (See also W91-07139) (Author's Abstract)
W91-07171

SELF IMPLEMENTED, PRACTICAL GROUND WATER MANAGEMENT PROGRAMS FOR INDUSTRIES.

K. D. Svitana.

IN: Hazardous and Industrial Wastes: Proceedings of the 21st Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1989. p 474-493. 11 fig, 5 ref.

Descriptors: *Groundwater management, *Groundwater pollution, *Industrial wastes, *Remediation, *Superfund, *Water pollution control, *Water pollution prevention, Aquifers, Economic aspects, Environmental impact, Environmental policy, Groundwater monitoring, Groundwater quality, Regulations, Resource Conservation and Recovery Act.

Since the passage of the Federal RCRA (Resource Conservation and Recovery Act) and CERCLA (Comprehensive Environmental Response, Compensation and Liability Act) and pending Well Head Protection Laws, industry has been giving serious consideration to the quality of groundwater resources at their sites. Unregulated on-site disposal practices or uncontrolled process discharges in the past may have caused groundwater quality impacts of which industries are not aware. However, these groundwater impacts are in violation of the above referenced laws and place responsibility and potential liability on corporations. The self-implemented groundwater management program consists of the following aspects: (1) definition of groundwater flows; (2) assessment of ground water qualities; and (3) aquifer hydraulics. All of these aspects can be phased so that costs can be distributed over a longer period, thus, reducing the financial burden. Research of present and past disposal and process practices including location of product storage and distribution facilities should be conducted to determine probable high impact areas. Overall groundwater flow at the site can be accessed by installing monitoring wells at strategic locations and determining the flow direction from static water table elevation data. Remedial controls can be defined by determining the subsurface flow hydraulics. All information collected also provides meaningful background data and can serve as a motivation for improving product storage and waste handling practices in order to avoid future soil and groundwater problems. The implementation of a groundwater management program, prior to regulatory intervention, allows industries to plan for remedial costs and manage accidental on-site discharges. This planned management practice decreases the capitol impact of last minute crises oriented remedial programs. (See also W91-07139) (Mertz-PTT)
W91-07172

ECOLOGICAL EXPOSURE/RISK ASSESSMENT OF HAZARDOUS WASTES.

Environmental Protection Agency, Washington, DC. Office of Environmental Processes and Effects Research.
W. C. LaVeille.

IN: Hazardous and Industrial Wastes: Proceedings of the 21st Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1989. p 497-505. 1 tab, 11 ref.

Descriptors: *Environmental impact, *Environmental policy, *Hazardous wastes, *Remediation, *Risk assessment, *Water pollution effects, Environmental effects, Health effects, Kinetics, Popula-

tion exposure, Public health, Superfund, Toxicology.

Evaluation of potential adverse impacts from hazardous waste sites or releases has in the past typically focused on human health implications. With the passage of SARA (Superfund Amendment and Reauthorization Act of 1986), the U.S. EPA is directed to establish regulations for the assessment of impacts on natural resources. Guidelines are being drafted by the Agency to assist in making ecological assessments a part of the hazardous waste remediation process. EPA's Office of Research and Development is contributing to this effort by developing field and laboratory methods for making these assessments in surface and subsurface, and terrestrial and aquatic environments, and by integrating them into ecological risk assessment strategies. Three elements of any risk assessment (exposure analysis, hazard analysis, and the integration of the two into a risk analysis) are addressed in research involving six levels of integration of individual projects. The six levels of integration include: (1) decision support systems, such as computer software and databases; (2) exposure analysis; (3) toxicokinetics; (4) biotic effects analysis; (5) population and community risk assessment; and (6) ecosystem risk assessment. Although ecological assessment has not usually been conducted in the past at Superfund sites, the requirement to do so is recognized. Because of the relatively large body of information, techniques, and guidance available on human health risk assessment and the extensive Superfund program experience gained from conducting such assessment for sites, they will continue to be extremely important factors for evaluating risk. Increasingly, however, as ecological risk assessment methodologies are improved and quantified through continued research, and understood and evaluated through the experience acquired from applications at actual waste sites, they too will have important consequences in guiding future remediation decisions. (See also W91-07139) (Mertz-PTT)
W91-07173

DETERMINATION OF REMEDIAL ALTERNATIVES AT A DIOXIN CONTAMINATED WASTE DISPOSAL SITE BY USE OF QUANTITATIVE RISK ASSESSMENT TECHNIQUES.
Environmental Resources Management, Inc., Exton, PA.
B. N. Stephanatos, and J. M. Sotsky.
IN: Hazardous and Industrial Wastes: Proceedings of the 21st Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1989. p 506-525. 3 fig, 6 tab, 8 ref.

Descriptors: *Cleanup operations, *Dioxins, *Environmental effects, *Hazardous wastes, *Risk assessment, Environmental impact, Health effects, Industrial wastes, Public health, Remediation measures, Superfund, Toxicity, Waste disposal, West Virginia.

The potential exposure to 2,3,7,8-TCDD (tetrachlorodibenzo-p-dioxin) originating from an old surface mine bench in West Virginia was examined. Level of risk to public health and the environment posed by contamination of the site was assessed. Wastes, both chemical and municipal, were placed in a ravine and on the old bench surface from 1962 through 1963. A hazardous waste survey showed site utilization in 1959 through 1960 of open drummed hazardous wastes and uncontained hazardous wastes. Background information also indicated that open burning was conducted at the site. Exposure scenarios for the waste disposal site were developed based on the assumption that use of the site would not change in the future and that the site would be allowed to revert to its natural state. Risks to public health and the environment were calculated following standard U.S. EPA guidelines for performing risk assessments at Superfund sites. Areas showing risk levels in excess of acceptable levels were examined with respect to the need for remediation. Estimating the public health risk of a chemical requires two types of information: the magnitude of human exposure to the chemical and the nature and severity of its toxicity. Based on the site data reviewed and on the exposure scenarios defined, no soil areas at the West Virginia site were identified that presented potential risks to public health. Therefore, no remediation alternatives were recommended for the site. (See also W91-07139) (Mertz-PTT)
W91-07174

RISK COMMUNICATION STRATEGIES: FOUR HAZARDOUS WASTE SCENARIOS.
ENSCO Environmental Services, Inc., Fremont, CA.
L. Nelowet, and F. Beuby.
IN: Hazardous and Industrial Wastes: Proceedings of the 21st Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1989. p 547-557.

Descriptors: *Communication, *Emergency planning, *Public policy, *Risk assessment, Community development, Environmental effects, Environmental policy, Hazardous wastes, Waste management.

A comprehensive community outreach program covers one or more of the following categories: information and education; the development of a receptive audience; disaster warning and emergency information; or mediation and conflict resolution. In developing a community outreach program, three steps must be understood and addressed: understanding objectives; knowing the audience and its concerns; and implementing the risk communication plan. Four of the most common scenarios in hazardous materials/waste management that require risk communication are examined: emergency response, remediation, facility siting, and ongoing plant operations. Whether the intention is to mitigate the impact of a potentially tragic accident, efficiently remediate an uncontrolled hazardous waste disposal site, successfully locate a new facility, or simply maintain friendly relations with facility neighbors, the risk communicator must understand the concerns of the audience and respond directly and honestly to those concerns. (See also W91-07139) (Mertz-PTT)
W91-07176

UNDERGROUND STORAGE TANKS--WHAT NOW.
Pirnie (Malcolm), Inc., Newport News, VA.
T. J. Fisher.
IN: Hazardous and Industrial Wastes: Proceedings of the 21st Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1989. p 561-570. 4 tab.

Descriptors: *Environmental law, *Legal aspects, *Regulations, *Superfund, *Underground storage tanks, *Water pollution sources, Chemical transport, Economic aspects, Petroleum products, Public policy.

On September 23, 1989, the U.S. EPA promulgated a regulation that governs all aspects of the estimated 2 million underground storage tanks containing petroleum or chemical products. On October 26, 1988, the EPA promulgated a related regulation that detailed the financial requirements relating to underground storage tank systems. These regulations apply to both owners and operators of underground storage tank systems and establishes requirements for demonstrating financial responsibility for taking corrective action for spills and leaks as well as compensating third parties for injury and property damage caused by leaks and spills. Together, these two regulations, in concert with the strict liability provisions as contained in the Superfund regulations provides for a comprehensive program that will affect virtually all underground storage tank owners. The regulations contain provisions for both new as well as existing tank systems. The financial assurance requirements that were finalized in October 1988 apply only to tanks containing petroleum products. The regulations stipulate that if you own or operate an underground tank or tank system that contains a petroleum product, you must be able to ensure, through one of several mechanisms, that there will be money available to help pay for cleaning up a leak or spill caused by your facility. The regulations indicate that both the owner and operator are liable for noncompliance with the regulations, even though only one party is responsible for complying. (See also W91-07139) (Mertz-PTT)
W91-07177

ECONOMICS OF AN EFFECTIVE UNDERGROUND STORAGE TANK (UST) MANAGEMENT PROGRAM.
C. F. Butler.
IN: Hazardous and Industrial Wastes: Proceedings of the 21st Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1989. p 571-581. 1 fig, 3 tab.

Descriptors: *Management planning, *Risk assessment, *Underground storage tanks, *Water pollution control, *Water pollution prevention, Economic aspects, Environmental law, Environmental policy, Land management, Legal aspects, Regulations.

The U.S. EPA published the final regulations for underground storage tank systems in 40 CFR (Code of Federal Regulations), Part 280 and 281. These regulations govern underground storage tank systems containing petroleum products and hazardous substances and include the technical requirements for new and existing system installations, as well as financial responsibility elements. Developing and implementing a comprehensive underground storage tank system management plan is a complex undertaking. Despite problems, when fundamental management principals are applied, overall underground storage tank system plans can be developed that are cost-effective and environmentally-sound. This starts with a solid foundation consisting of an extensive tank population inventory/data base development task. Underground storage tank systems identified in high risk categories should receive priority attention while lower risk tanks can be addressed on a planned, systematic basis. Implementation of the remaining underground storage tank management tasks including system upgrading/retrofitting; installation of replacement systems, closure and remediation for existing underground storage tanks; and compliance with financial responsibility elements should be consistent with the overall management strategy. Underground storage tank owners seeking to minimize risk will adopt an aggressive, proactive approach, which is generally not the least-cost method. Underground storage tank system owners designing a more economical overall approach must be willing to accept the higher potential risks associated with this philosophy. Either way, implementation of a strategic underground storage tank management plan will assist in minimizing the economical burden, complexity and headaches brought on by recent regulatory requirements. (See also W91-07139) (Mertz-PTT)
W91-07178

CASE HISTORY OF A TURNKEY CLOSURE OF A PESTICIDE SITE.
Allied-Signal, Inc., Morristown, NJ.
W. Yanovitch, S. A. Rock, W. F. Beers, and J. W. Hammond.
IN: Hazardous and Industrial Wastes: Proceedings of the 21st Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1989. p 612-627. 5 fig, 1 tab.

Descriptors: *Minnesota, *Pesticides, *Site remediation, *Water pollution treatment, DDD, DDE, DDT, Environmental management, Environmental policy, Groundwater monitoring, Groundwater pollution, Industrial wastes, Insecticides, Path of pollutants, Soil analysis, Xylenes.

An agricultural chemical company property, located in Minneapolis, Minnesota, was used for formulating, packaging, and warehousing a variety of finished pesticide products. Following the discontinuation of the pesticide-related operation, the Minnesota Pollution Control Agency ordered an investigation of the site for potential levels of residual pesticides remaining on the site. The investigation included the installation of test pits, soil borings, and groundwater monitoring wells. Soil and groundwater samples collected were analyzed for toxaphene, aldrin, DDE (2,2-bis(p-chlorophenyl)-1,1-dichloroethylene), DDD (2,2-bis(p-chlorophenyl)-1,1-dichloroethane), DDT (2,2-bis(p-chlor-

ophenyl)-1,1,1-trichloroethane), and combined DDE and dieldrin. Additionally, groundwater samples were analyzed for several volatile organics used in pesticide formulations. The investigation revealed elevated concentrations of pesticides in the some of the soils. Trace concentrations of several pesticides and xylene were sporadically detected in the shallow perched groundwater. Activities completed after the investigation included: preparation of a Remedial Investigation report; evaluation of remedial alternatives for the site; preparation of a Response Action Plan for the selected remedial alternative; and execution of the onsite remediation. In the fall of 1988, the cleanup of the contaminated soils in the site was completed. The overall site investigation and remediation project at the site were accomplished over a 5-year period (1983-1988). By implementing the project on a turnkey basis, using a single consultant/contractor for all phases of the project, the chemical company was able to retain access to the technical personnel with the understanding of the project's history to provide guidance and coordination to remediation personnel at points of uncertainty during the cleanup. This capability resulted in the successful renegotiation of the cleanup criteria and overall savings in the cleanup costs. (See also W91-07139) (Mertz-PTT)
W91-07181

ALTERATION OF IN SITU REDOX POTENTIAL TO ENHANCE MICROBIAL DECHLORINATION OF PCBS.
Pittsburgh Univ., PA. Dept. of Civil Engineering.
S. F. Pedersen, and R. D. Neufeld.
IN: Hazardous and Industrial Wastes: Proceedings of the 21st Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1989. p 628-639. 1 tab, 18 ref.

Descriptors: *Biodegradation, *Cleanup, *Dehalogenation, *Polychlorinated biphenyls, *Site remediation, *Water pollution treatment, Anaerobic digestion, Biological treatment, Degradation, Degradation products, Halogenated organic compounds, Microorganisms, Waste treatment.

Since PCBs (polychlorinated biphenyls) were first identified in the environment, they have been found to be a stable contaminant that is degraded very slowly. The driving force for establishment of in situ treatment involves several factors: one is the fact that PCBs bioaccumulate in organisms, particularly in fish; another is that disposal of PCB contaminated soils and sediment are often difficult and expensive, due to the large quantity of material to be handled. A sequence of anaerobic conditions, followed by aerobic conditions, in the presence of a suitable microbial population, were investigated as a possible treatment process for the complete in situ degradation of PCBs. The reductive dechlorination of highly chlorinated PCB molecules was examined to identify and quantify the factors that affect the reductive dechlorination process. To achieve these objectives, the environmental conditions for the dehalogenation step varied. Variables included: the reductive potential of the soil; the amendment used for lowering the reductive potential; and the addition of an acclimated anaerobic microbial consortium. Because the computer program used produced essentially meaningless results, conclusions were drawn from a summary sheet. The addition of l-cystine hydrochloride was essential for dechlorination. No other variable appeared to be an important factor in causing dechlorination. Over a four month period, approximately 50% of the 2,2',4,4',5,5' hexachlorobiphenyl (HCB) was dechlorinated. Most of the dechlorination product was the first product, probably a tetrachlorobiphenyl. In addition, it was found that a limited amount of dechlorination took place in the absence of any amendments. Dechlorination was not dependent on the supplying of seed organisms, but rather was accomplished by naturally occurring soil organisms. It was shown that engineered organisms tended to die out quickly when exposed to naturally occurring conditions. (See also W91-07139) (Mertz-PTT)
W91-07182

IN SITU SOIL BIOREMEDIATION: THE INTERFACE BETWEEN BIOLOGY AND ENGINEERING.
Biodetox, Inc., Newark, DE.
K. H. Baker, D. L. Wegman, and D. S. Herson.
IN: Hazardous and Industrial Wastes: Proceedings of the 21st Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1989. p 640-650. 2 fig, 1 tab, 12 ref.

Descriptors: *Bioremediation, *Cleanup, *Environmental engineering, *Monitoring, *Site remediation, *Soil contamination, *Water pollution treatment, Biological treatment, Carbon dioxide, Environmental effects, Hazardous wastes, Industrial wastes, Microorganisms, Waste treatment.

Success of bioremediation depends upon the collaboration between biologists and engineers at all stages of the design and implementation process. Of utmost importance is the monitoring of the biological response during the implementation and progress of bioremediation. In order for an assay technique to be acceptable for routine field monitoring of bioremediation it must meet the following criteria: the assay must be rapid; it should be relatively easy to perform; and the assay should be inexpensive to conduct allowing for frequent, multiple samples without an undue additional expense to the client. Bioremediation at two sites in a refrigerant/coolant plant in south-central Pennsylvania was instituted after preliminary engineering and microbiology feasibility studies demonstrated that this approach to remediation was appropriate for contaminants found at the plant. The areas under concern were soils contaminated with a mixture of hydrocarbons. Microbiology feasibility studies included cultural studies, community respiration studies, and mass balance studies. In situ monitoring of microbial community activity is a necessary adjunct to proper engineering for successful bioremediation of hazardous waste contaminated soils. Measurement of carbon dioxide evolution using lysimeters provided a simple, inexpensive and reliable method for achieving such monitoring. (See also W91-07139) (Mertz-PTT)
W91-07183

SOIL WASHING TECHNIQUES FOR REMOVAL OF CHROMIUM CONTAMINANTS FROM SOIL.
New Jersey Inst. of Tech., Newark. Dept. of Civil and Environmental Engineering.
H. N. Hsieh, D. Raghu, J. W. Liskowitz, and J. Grow.
IN: Hazardous and Industrial Wastes: Proceedings of the 21st Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1989. p 651-660. 4 fig, 1 tab, 10 ref.

Descriptors: *Chromium, *Cleanup, *Site remediation, *Soil contamination, *Water pollution treatment, Alkalinity, Bentonite, Clay soils, Hydrogen ion concentration, Kaolinite, New Jersey, Sandy soils, Soil chemistry, Soil properties, Soil washing, Waste treatment.

Before 1965, New Jersey was a major processing area for chromium production. This activity generated about 2.75 million tons of alkaline waste. The waste was mixed with soil and used as fill material. Problems of environmental pollution have risen from the disposal of chromium bearing wastes. In order to remove the chromium from soil, factors affecting adsorption and desorption of chromium on soil were studied. The first part of the research focused on the effect of chromium concentration, the type of the soil, and pH on chromium adsorption. A preliminary test on soil washing was performed on chromium bearing soil. The total chromium concentration in the soil was between 10,000 and 22,000 parts per million. Based on experiments conducted, several conclusions were drawn. Adsorption of chromium was related to the type of soil and the properties of soil. Clayey soil adsorbed more chromium than sandy soil. Bentonite adsorbed more chromium than kaolinite. Adsorption of chromium was associated with the changing pH. Trivalent chromium precipitated at a pH above 5.5. More hexavalent chromium was adsorbed on clay at a pH range between 6 and 10. Chromium concentration presented in the soil affected the property of the soil. Bentonite tended to swell at low chromium concentration and kaolinite formed a suspended solid solution at high chromium concentration. Particle size affected the chromium concentration in the soil. Possible methods to separate chromium from soil included density separation column, flotation, pH adjustment, oxidation and reduction, and precipitation. (See also W91-07139) (Mertz-PTT)
W91-07184

VADOSE ZONE TREATMENT USING PNEUMATIC FRACTURING.
New Jersey Inst. of Tech., Newark. Dept. of Civil and Environmental Engineering.
J. R. Schuring, P. C. Chan, and P. Papanicolaou.
IN: Hazardous and Industrial Wastes: Proceedings of the 21st Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1989. p 663-668. 3 fig, 6 ref.

Descriptors: *Fracture permeability, *Groundwater pollution, *Pneumatic fracturing, *Site remediation, *Vadose zone, *Water pollution treatment, Air pressure, Geologic fractures, Groundwater movement, Permeability, Waste treatment.

The groundwater environment is generally divided into two major zones: (1) the unsaturated zone, also know as the vadose zone; and (2) the saturated zone. The vadose zone extends from the ground surface down to the groundwater table. The saturated zone begins at the groundwater table, and extends to depth. Treatment of the vadose zone is high priority in any groundwater remediation action since transport of the contaminants from the unsaturated to the saturated zones occurs continuously by percolation and vapor transport. A new process, known as pneumatic fracturing, is designed to enhance in situ clean-up actions. The process consists of inserting a tubular probe and nozzle into the soil. High pressure air is then injected through the probe to create fractures. The inserted probe can be advanced at intervals to provide the desired degree of fracturing and aeration, and then reinserted at various locations. The principal effect that pneumatic fracturing has on the structure of the soil is that it establishes conductive channels that permit more rapid movement of liquid and vapor through the soil matrix. This is beneficial since essentially any treatment technology is limited by the permeability of soil formation being treated. Results from bench-scale laboratory studies have demonstrated that pneumatic fracturing has the potential to reduce treatment time as well as extract greater amounts of contaminant. The process may also make it possible to treat soils with low permeabilities for which present in situ methods are largely ineffective. (See also W91-07139) (Mertz-PTT)
W91-07185

REMEDIAL ACTION PLAN TO PREVENT OIL SEEPAGE INTO A LOCAL CREEK.
Sun Refining and Marketing Co., Marcus Hook, PA.
A. J. Raymond.
IN: Hazardous and Industrial Wastes: Proceedings of the 21st Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1989. p 680-681.

Descriptors: *Cleanup, *Cleanup operations, *Oil pollution, *Oil wastes, *Oily water, *Site remediation, *Water pollution prevention, Oil industry, Pennsylvania, Secondary recovery, Water pollution control.

The Marcus Hook Refinery is located in the southeastern corner of Pennsylvania and has disposed of oily spent clay at a site two miles from the Marcus Hook facility from 1925-1969. This 71 acre site contains three individual piles of approximately 500,000 cubic yards of spent clay. The largest clay pile is located on the south bank of a small creek and over a period of time oil has been seeping into the creek. To prevent seepage an oil recovery system at the clay pile was implemented. The system is an on-site recovery system that has been fully operational since August 1984. The total

product recovered by this probe scavenger and hand boiling system was 20,000 gallons. In early 1988, small amounts of hydrocarbon started to appear in the creek and additional work had to be initiated. Two new projects were initiated to completely remove the hydrocarbon from the creek. The first project was the regrading and capping of the clay pile. The cap system must possess sufficient strength and durability to provide a long-term protector/isolation function. The cap was composed of relatively homogenous material so that it remained intact during its service life. To fulfill requirements, the interceptor/drainage layer, a primary cap soil layer, topsoil cover layer and vegetative cover was used. The second project is a new french drainage system and infiltration gallery. (See also W91-07139) (Mertz-PTT)
W91-07187

SUPERFUND RECORD OF DECISION, KIMBERTON, PA, FIRST REMEDIAL ACTION.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-206353. Price codes: A05 in paper copy, A01 in microfiche. 87 p, 11 fig, 2 tab.

Descriptors: *Cleanup operations, *Kimberton Superfund Site, *Path of pollutants, *Superfund, Backfill, Dichloroethylene, Excavation, Groundwater pollution, Pennsylvania, Revegetation, Trichloroethylene, Vinyl chloride, Volatile organic compounds, Wastewater lagoons, Water pollution sources.

The Kimberton site is located in the northeastern portion of Chester County, Pennsylvania, near the Philadelphia metropolitan area. The site encompasses the Monsey Products Company property and adjacent properties within the surrounding Village of Kimberton. Several buried lagoons are located in the site. The lagoons received various residues from the manufacturing operations from 1947-1959. In August 1981, volatile organic compounds (VOCs) were first detected during routine water quality testing of a private well on Monsey property. EPA's subsequent investigation in early 1982 indicated that soil, groundwater, and surface water were contaminated by VOCs, including dichloroethylene, trichloroethylene, and vinyl chloride. The lagoons were identified as a source of contamination, and subsequently, approximately 2,050 cu yd of contaminated soil from three former lagoon areas were excavated and disposed of off-site in September 1984 as part of a site remedial action plan. The excavations were backfilled, regraded and revegetated. (Lantz-PTT)
W91-07190

SELECTED TOOLS AND TECHNIQUES FOR PHYSICAL AND BIOLOGICAL MONITORING OF AQUATIC DREDGED MATERIAL DISPOSAL SITES.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
T. J. Fredette, D. A. Nelson, T. Miller-Way, J. A. Adair, and V. A. Sotler.
Available from the National Technical Information Service, Springfield, VA. 22161 as AD-A229 442. Price codes: A06 in paper copy, A01 in microfiche. Technical Report D-90-11, September 1990. Final Report. 106p, 34 fig, 2 tab, 70 ref.

Descriptors: *Biological studies, *Dredging wastes, *Instrumentation, *Measuring instruments, *Monitoring, *Water analysis, *Water quality, Bathymetry, Benthic fauna, Bioassay, Crabs, Current meters, Data acquisition, Fish, Navigation, Ocean dumping, Photography, Sampling, Shrimp, Waste disposal.

Monitoring of aquatic dredged material disposal sites may require a variety of physical and biological tools and techniques. Changes in physical environment, such as mounding, can result in a navigation hazard or lead to burial of the biological community, which necessitates biological monitoring. Design of a monitoring program must consider what equipment to use and at what spatial and temporal frequency to sample. These factors will be determined by the level of information required for the questions being addressed, given present technical, monetary, regulatory, and political considerations. Physical monitoring tools can be broadly classified into several groups. Navigation and positioning equipment are primary among these. The effectiveness of all sampling depends upon knowing the location of a sample relative to the disposal site. Equipment that measures bathymetry and ocean bottom configuration with acoustic energy is a second group. A third group of physical instruments consists of those that directly sample sediment. These range from grab samplers, which one person can operate to retrieve a small surface sample, to large vibracores that return a core through a disposal site. A fourth group of tools for physical monitoring includes those instruments that return data on site conditions remotely through the use of photography. In situ measurements of engineering properties of mounds are possible with a fifth group of tools. Waves and current meters form the last group of tools that may be useful in physical monitoring. They are used to measure the driving forces for sediment transport. Fish and shellfish are generally the animals of the greatest socioeconomic importance to individuals and agencies. Sampling of nektonic organisms (fish, shrimp and crabs) is most commonly accomplished through the use of nets or traps. Benthic infauna and submergent vegetation are regarded as good indicators of environmental quality. Grab samplers and box corers are the tools of choice for quantitative sampling of these organisms. (Lantz-PTT)
W91-07191

REPORT TO CONGRESS: INDIAN WASTEWATER TREATMENT, NEEDS AND ASSISTANCE.
Environmental Protection Agency, Washington, DC. Office of Municipal Pollution Control.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-187421. Price codes: A03 in paper copy, A01 in microfiche. Report No. EPA 430/09-88-006, January 1989. 32p, 10 fig, 3 append.

Descriptors: *Clean Water Act, *Indian reservations, *Wastewater treatment, *Water quality, Financing, Indian Health Service, Legislation, Social aspects.

This report has been prepared in cooperation with the Indian Health Service (IHS) to meet the requirements of Section 518(b) of the Clean Water Act (CWA) as amended by the Water Quality Act (WQA) of 1987. The report's five major objectives are as follows: (1) to summarize EPA's assessment of Indian wastewater treatment construction needs; (2) to report on the degree to which such needs will be met through CWA funding; (3) to identify any obstacles which may prevent such needs from being met; (4) to discuss how EPA plans to implement the Indian Set-Aside Program established under Section 518(c) of the CWA; and (5) to describe EPA's efforts to maximize Indian participation in CWA programs. (Lantz-PTT)
W91-07193

WATER QUALITY OF SELECTED TAILWATERS.
Ouachita Baptist Univ., Arkadelphia, AR. Dept. of Chemistry.
For primary bibliographic entry see Field 5B.
W91-07199

SUPERFUND RECORD OF DECISION: BURNT FLY BOG, NJ.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-206304. Price codes: A03 in paper copy, A01 in microfiche. Report No. EPA/ROD/R02-88/072, September 1988. 49 p, 4 fig.

Descriptors: *Cleanup operations, *New Jersey, *Superfund, *Water pollution sources, Excavation, Lead, Oil wastes, Polychlorinated biphenyls, Soil contamination, Surface water, Waste capping, Waste disposal.

The Burnt Fly Bog site is located in Marlboro Township, Monmouth County, New Jersey. The area is affected by contamination from a 10 acre parcel where waste was originally deposited (Uplands Area Operable Unit). The site includes both flood plains and wetlands. Contamination has been detected in the surface water, surface spoil, and the shallow subsurface soil as a result of uncontrolled discharges and runoff from the Uplands Area waste sources. The Uplands Area includes several abandoned oil storage and treatment lagoons containing residual oil sludges and aqueous wastes, contaminated waste piles, and buried or exposed drummed wastes. These are the result of activities at the site from 1950-1965. The Uplands Area is currently being cleaned up under a Record of Decision signed in November 16, 1983. The volume of soil contaminated with PCBs and lead is estimated to be 76,400 cu yd at the site, with an additional 5,600 cu yd of contaminated sediments in an adjacent downstream area. There is no evidence of PCB contamination in the surface water. The primary contaminants of concern affecting the surface water, soil and sediments are PCBs and lead. The selected remedial action for this site includes: access restrictions; excavation of contaminated sediments from the downstream area with disposal at an offsite RCRA Subtitle C facility; and containment without capping contaminated soil through installation of a sedimentation basin and appropriate diversion controls. (Lantz-PTT)
W91-07203

SUPERFUND RECORD OF DECISION, ALLIED CHEMICAL, OH.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-206221. Price codes: A05 in paper copy, A01 in microfiche. Report No. EPA/ROD/R05-88/078, September 1988. 89 p, 7 fig, 7 tab.

Descriptors: *Cleanup operations, *Groundwater pollution, *Hazardous wastes, *Ohio, *Superfund, Anthracene, Benzene, Cyanide, Heavy metals, Oil wastes, Organic compounds, Path of pollutants, Polycyclic aromatic hydrocarbons, Volatile organic compounds, Waste disposal.

This remedial action addresses the Goldcamp Disposal Area (GDA) operable unit of The Allied Chemical site located in Ironton, Lawrence County, Ohio, The site is a four acre disposal pit located in a mixed industrial/business/residential area. The GDA was a sand and gravel pit used for disposal of various chemical wastes from three sources between 1945 and 1977. The wastes include anthracene residue, anthracene salts, phthalic anhydride residue, and miscellaneous process wastes from the Tar Plant; foundry sand containing heavy metals, phenolics, and oils from the Dayton Malleable Iron Company; and wastes disposed of by the Goldcamp Gravel Company. In 1977, Allied decided to discontinue use of the GDA for disposal of chemical wastes. Allied and its contractor in consultation with the Ohio Environmental Protection Agency (OEPA), completed a closure project at the site in August 1980, which involved removal of standing liquids, and filling and capping the site with clay. Subsequent geohydrologic and water quality investigations indicated that there is groundwater contamination at the site which may pose a threat to public health through migration. The extent of the contaminated area is uncertain, but the volume is estimated to be 156,000 cu yds. The primary contaminants of concern affecting the soil and groundwater are: VOCs (including benzene), other organics including phenols and PAHs, and inorganics including cyanide. Selected remedial action includes: construction of a slurry wall around the disposal area from ground surface into the low permeability bedrock; installation of a multi-media RCRA cap over the surface of the disposal area; and extraction and onsite treatment of groundwater from inside and outside the containment system. (Lantz-PTT)
W91-07204

SUPERFUND RECORD OF DECISION, RHINEHART TIRE FIRE, VA.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-206288. Price codes: A03 in paper copy, A01 in microfiche. Report No. EPA/ROD/R03-88/050, June 1988. 34 p, 1 fig, 2 tab.

Descriptors: *Cleanup operations, *Fire effects, *Path of pollutants, *Rhinehart Tire Fire Superfund Site, *Superfund, *Virginia, Arsenic, Groundwater pollution, Industrial wastes, Lead, Oil wastes, Potomac River Basin, Pyrolysis, Soil contamination.

The Rhinehart Tire Farm (RTF) site is located in a sparsely populated rural area in Western Fredrick County, Virginia. A tire disposal operation was conducted at the site from 1972-1983. Disposal consisted of transporting discarded tires from various sites and storing them on a wooded slope. By October 1983, 5 to 7 million tires had accumulated. These tires caught fire on October 31, 1983, producing a hot oil from the melting and pyrolysis of the tires, which seeped from the pile of tires into Massey Run. An undetermined quantity of oil flowed into Hoque Creek, which is a tributary to the Potomac River system. Approximately 800,000 gallons of oil product was collected, removed, and recycled into fuel oil from a 50,000 gallon lined pond constructed downslope of the burn area. A Remedial Investigation (RI) was conducted to characterize and define the extent of possible contaminants. The RI indicated that the ash contamination continues with both solid residue and liquid seepage by means of precipitation. Selected remedial action for this site includes: collection of surface runoff with gravity settling; collecting of shallow groundwater oily seeps; oil water separation and transport of the water to a publicly owned treatment work; construction of berms to increase freeboard on two existing onsite ponds; and implementation of soil erosion controls. (Lantz-PTT)
W91-07205

SUPERFUND RECORD OF DECISION, SOUTH CAVALCADE STREET, TX.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-206270. Price codes: A04 in paper copy, A01 in microfiche. Report No. EPA/ROD/R06-88/045, September 1988. 75 p, 3 fig, 5 tab.

Descriptors: *Cleanup operations, *Houston, *Path of pollutants, *Superfund, *Texas, *Wood preservatives, Aquifers, Arsenic, Benzene, Chromium, Creosote, Excavation, Groundwater pollution, Lead, Metals, Polycyclic aromatic hydrocarbons, Salts, Soil contamination, Toluene, Volatile organic compounds, Waste containment, Xylenes.

The 66 acre South Cavalcade site is located in northeast Houston, Texas. The site was used as a wood preserving and coal tar distillation facility from 1910 to 1962. The wood preserving facility consisted of an operations area, a drip track, and treated and untreated wood storage areas. Creosote and metallic salts were used in the operation. Beginning in November 1985, EPA sampled all environmental media and found two discrete areas of contamination corresponding to the location of the wood treating operations and the coal tar plant in the southern portion of the site, and a pond which previously existed in the northern portion of the site. Polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs), metals and components of creosote were detected in the soil, sediments, and groundwater. VOCs including benzene, toluene, and xylenes, and other organics including PAHs and metals including arsenic, chromium, and lead, were the primary contaminants of concern. Selected remedial action for this site includes: excavation and onsite washing of 19,500 cu yds of soil; replacing the soil in the excavated areas and capping and treating washwater in the groundwater treatment system; in situ soil flushing of 10,500 cu yds of soil; and groundwater pump and treatment of 50,000,000 gallons using physical and chemical separation, pressure filtration, and carbon adsorption with reinjection into the aquifer. (Lantz-PTT)
W91-07206

SUPERFUND RECORD OF DECISION, WAUSAU WATER SUPPLY, WI.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-229520. Price codes: A05 in paper copy, A01 in microfiche. Report No. EPA/ROD/R05-89/086, December 1988. 78 p, 10 fig, 9 tab.

Descriptors: *Cleanup operations, *Groundwater pollution, *Superfund, *Water supply, *Wausau Water Supply Superfund Site, *Wisconsin, Extraction, Groundwater mining, Monitoring, Volatile organic compounds, Wells.

The Wausau Water Supply site includes 5 of 6 production wells in the City Well Field located on both sides of the Wisconsin River. The wells supply nearly all the potable water for approximately 33,000 people, as well as irrigation and industrial water to surrounding areas. In 1982, 3 of the wells were discovered to contain volatile organic compounds (VOCs). In 1983 the EPA granted funds to help design and install a packed tower VOC stripper, and in June 1984 installed a granular activated carbon (GAC) treatment system on one of the wells (CW6) in response to an increase in VOC concentration. Currently, the city continues to blend treated water with water from uncontaminated supply wells to ensure low VOC levels in its water supply. The scope of this expedited operable unit is limited to the contaminant plume affecting CW6 in the West Well Field. The primary contaminants of concern at the West Well Field are VOCs including trichloroethane. The selected remedial action for this site includes: groundwater pumping and treatment using air stripping with discharge to the Wisconsin River; groundwater monitoring; and provision for implementation of an additional extraction well as necessary. (Lantz-PTT)
W91-07207

SIMULTANEOUS, MULTIPLE-LEVEL WITHDRAWAL FROM A DENSITY STRATIFIED RESERVOIR.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
For primary bibliographic entry see Field 8B.
W91-07211

SUPERFUND RECORD OF DECISION: ROCKY HILL, NJ.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-206296. Price codes: A04 in paper copy, A01 in microfiche. Report No. EPA/ROD/R02-88/061, June 1988. 56p, 8 fig, 6 tab.

Descriptors: *Cleanup operations, *Groundwater pollution, *Rocky Hill Superfund Site, *Superfund, *Water pollution sources, Air stripping, Groundwater mining, Groundwater quality, Monitoring, Path of pollutants, Potable water, Trichloroethyelene.

The 2-acre Rocky Hill Municipal Well Field site (RHMW) is located in Montgomery Township, Somerset County, New Jersey. Montgomery Township Housing Development (MTHD) located north of the well field contains 77 private homes. RHMW is listed on both the State and National Registers of Historic Places. Additionally, a nearby corridor has potential for archaeological significance. Two wells, numbered 1 and 2, were constructed in 1936 to provide a source of potable water to the Borough of Rocky Hill (BRH). A 1978 Rutgers University study revealed trichloroethylene (TCE) contamination levels in Well 1, and it was abandoned and sealed by 1978. Further testing, conducted between 1978 and 1983 revealed cycles of elevated levels of TCE in Well 2. It was closed in November 1979. Declining levels of TCE in the well field resulted in the reopening of the well; however, levels increased and the well was again closed in January of 1982. During the shutdown of Well 2, BRH obtained potable water from the privately owned Elizabethtown Water Company. After the installation of two air stripping units by the borough, Well 2 reopened as a potable water source. Recently, 38 MTHD residents elected to connect to the municipal supply. The first operable unit Record of Decision (ROD), signed in September 1987, provided for the supply of alternate water through the permanent hookup of all remaining MTHD residences and 6 residences outside of MTHD. Approximately 13 possible sources of contamination are under evaluation. TCE is the most predominant site contaminant, both with respect to concentration and areal extent. Several additional components such as chlordane and metals are sporadically present; however, these compounds were not considered to be related to the TCE contamination. The selected remedial action for this site includes: groundwater pump and treatment using air stripping with reinjection; connection of any remaining affected residences to the public water supply; sealing remaining private water supply and monitoring wells within the contamination plume; and implementation of groundwater sampling program to monitor the effectiveness of the cleanup. (Author's abstract)
W91-07218

WATER QUALITY OF INTERSTATE STREAMS IN THE SUSQUEHANNA RIVER BASIN. MONITORING REPORT 3: WATER YEAR 1989.
Susquehanna River Basin Commission, Harrisburg, PA. Resource Quality Management and Protection Div.
For primary bibliographic entry see Field 5B.
W91-07219

STUDY OF INNOVATIVE TECHNIQUES TO REDUCE SUBSURFACE DRAINAGE FLOWS.
Lord (J.M.) Inc., Fresno, CA.
Phase III Report, October 1989. 69p, 33 fig, 11 tab. Bureau of Reclamation Contract No. 9-FC-20-07880.

Descriptors: *Drainage programs, *Irrigation practices, *Subsurface drainage, *Water pollution control, Agriculture, Boron, Drainage, Drainage practices, Drainage systems, Flow pattern, Irrigation management, Salinity, Valves, Water table.

This Phase III report summarizes results of a two-year field study of irrigation management/controlled drainage techniques to reduce subsurface flows and constituent loads in the San Joaquin Valley, California. For Phase III, three west-side fields were chosen for study. Field B10-2 was a 150 acre tomato field located in Broadview Water District. Field P-1 was a 93 acre tomato field located in Panoche Water District. Field W-3 was a 152 acre cotton field located in Westlands Water District. Early in the 1989 season, the tile drainage system on Field B10-2 was modified by installing DOS-IR Valves to control the drainage outflow. Irrigation and drainage monitoring data indicated that irrigation management and controlled drainage during 1989 resulted in limiting deep percolation to 1.9 inches. Upflux was calculated at 3.4 inches. Approximately 15% more salts and 12% more boron left the field in the drainage effluent than was applied through irrigation water. Six additional DOS-IR Valves were installed in the tile system at mid-field of Field P-1 early in the 1989 season. Six valves were previously installed at the north field boundary in 1988. These additional valves were needed to provide additional water table control. During the 1989 installation it was decided to effectively shut off the tile system in order to keep the water table as high as possible. The combination of irrigation and controlled drainage management techniques resulted in 3.8 inches of deep percolation and 2.6 inches of upflux. A statistical analysis indicated that there was no significant difference in salinity and boron levels between sampling dates over the course of the study. Due to grower operational concerns for the

season, and high water table conditions, the DOS-IR Valves could not be installed on Field W-3. This prevented implementation of actively controlled drainage management. However, some drainage control was effected by control of the sump pump. Lack of a tile discharge measuring point made it necessary to estimate tile flows based on deep percolation losses. These data indicated that 60% more salts and 10% more boron infiltrated with the irrigation water than left the field in the drainage effluent. Soil sample data from the autumns of '87, '88 and '89 showed a statistically significant increase in salinity and boron levels over this period. This is due to the continued recycling of tailwater and drainage effluent necessary due to the lack of a drainage outlet for these lands. (Lantz-PTT)
W91-07223

MITIGATION OF ACIDIC CONDITIONS IN LAKES AND STREAMS.
Electric Power Research Inst., Palo Alto, CA.
D. B. Porcella, C. L. Schofield, J. V. DePinto, C. T. Driscoll, and P. A. Bukaveckas.
IN: Acidic Precipitation. Volume 4: Soils, Aquatic Processes, and Lake Acidification. Advances in Environmental Science. Springer-Verlag, New York. 1990. p 159-186, 3 fig, 2 tab, 112 ref.

Descriptors: *Acid lakes, *Acid rain, *Acid streams, *Limestone, *Neutralization, *Water pollution control, *Water pollution treatment, Aluminum, Aquatic environment, Chemical treatment, Ecosystems, Hydrogen ion concentration, Model studies.

Limestone treatment is a practical and proven method for treating acidic surface waters. The major controlling factors have to do with the cost of treatment and the effectiveness of restoring ecological conditions in the surface waters. Two major uncertainties with regard to the latter concern the effect of episodic acidification on fish and invertebrates, and the levels of fish production attainable with long-term maintenance liming. Conclusions drawn from this literature review include: (1) calcitic limestone is favored and most commonly used for treating surface waters; (2) proper selection of powder sizes can allow a broad range of treatment alternatives as well as minimize dissolution problems; (3) models should incorporate CO2 influx from the atmosphere and sediment interactions so as to accurately simulate calcite dissolution; (4) sediment treatment can extend the treatment duration of lakes; (5) highly organic waters do not require special evaluation for treatment with limestone; (6) aluminum and trace metals are reduced effectively by liming, but the mechanisms that cause their removal appear to vary; (7) treatment with limestone benefits fish survival and reproduction. Fish production of limed lakes is typical of circumneutral lakes; (8) a major ecological effect of mitigation is caused by the stocking of fish; (9) introduction of fish and other species may be necessary to shorten the time required to attain species composition similar to circumneutral lakes; (10) the low nutrient conditions found in treated lakes apparently limit production; and (11) no evidence of aluminum toxicity at high pH exists, and the hypothesis that initial toxicity to fish exists due to formation of Al(OH)4(-) is untenable. (See also W91-07227) (Lantz-PTT)
W91-07233

RECOVERY OF ACIDIFIED AND METAL-CONTAMINATED LAKES IN CANADA.
Toronto Univ. (Ontario). Inst. for Environmental Studies.
M. Havas.
IN: Acidic Precipitation. Volume 4: Soils, Aquatic Processes, and Lake Acidification. Advances in Environmental Science. Springer-Verlag, New York. 1990. p 187-205, 2 fig, 3 tab, 32 ref.

Descriptors: *Acid lakes, *Acid rain, *Acidification, *Canada, *Case studies, *Heavy metals, *Water pollution treatment, *Water quality, Alkalinity, Aquatic environment, Ecological effects, Ecosystems, Fate of pollutants, Fish, Hydrogen ion concentration, Phytoplankton, Rotifers, Sulfates, Sulfur dioxide, Trace metals.

Three case studies that deal with the recovery of aquatic ecosystems from acidic stress are presented. These studies include: (1) the experimental acidification and partial recovery of Lake 223 in the Experimental Lakes Area (ELA) of northwestern Ontario; (2) the recovery of two severely acidified and metal-contaminated lakes near the now-closed Coniston Smelter in Ontario; and (3) the recovery of moderately acidified lakes in the Sudbury region of Ontario following regional reductions of SO2 emissions. All of these studies indicate that lake water quality improves rapidly once acidic inputs are reduced. Improvements include an increase in pH, a decrease in SO4 concentrations, and a decrease in concentrations of trace metals. Rapid recovery is attributed primarily to in situ alkalinity production (bacterial SO4 and NO3 reduction) and to the natural flushing of lakes. Geological weathering within the drainage basin in areas of base-poor bedrock is not an important source of lake alkalinity. Improvements in water quality are followed by changes in biota. New species may invade unoccupied niches, and rare species may become more abundant when their natural predators and competitors are eliminated or when their food supply increases. Rapidly reproducing species, such as rotifers and phytoplankton, are among the first to become better established in lakes recovering from acidification. Amphibians and fish become more abundant once the pH is sufficiently high to allow them to reproduce successfully. However, information about biological recovery is still insufficient to enable us to determine to what extent and at what rate the biota do recover naturally following reductions of acidic and trace metal inputs. (See also W91-07227) (Author's abstract)
W91-07234

WATER QUALITY ENRICHMENT TECHNIQUES USED WITHIN THE CORPS OF ENGINEERS.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
R. E. Price.
Available from the National Technical Information Service, Springfield, VA. 22161 as AD-A231 356. Price codes: A03 in paper copy, A01 in microfiche. Miscellaneous Paper W-90-1, October 1990. Final Report. 38p, 10 fig, 2 tab, 19 ref, append.

Descriptors: *Surveys, *Water pollution control, *Water quality, *Water quality control, *Water quality management, *Water resources development, Corps of Engineers, Data acquisition, Water management.

This report examines the findings of a US Army Corps of Engineers (CE) questionnaire sent to each CE District in 1988. This questionnaire requested information regarding project authorization, design, water quality attributes, and water quality enhancement techniques. The degree of success, approximate cost, and any associated disadvantages of the particular techniques were also requested. Responses were received from 17 Districts representing 9 Divisions. Enhancement techniques for 96 projects were reported. The water quality concerns were categorized according to location (tailwater, pool, or lock and dam) and are discussed in respective order by frequency of occurrence from questionnaire responses. Twenty-eight different enhancement techniques were identified with some projects listed as still under investigation. Of the categories of techniques, operational methods were reported to be the most successful. (Author's abstract)
W91-07238

CHESAPEAKE BAY NONPOINT SOURCE PROGRAMS.
Environmental Protection Agency, Annapolis, MD. Chesapeake Bay Liaison Office.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-152037. Price codes: A07 in paper copy, A01 in microfiche. January 1988. 122p, 7 fig, 29 tab.

Descriptors: *Chesapeake Bay, *Chesapeake Bay Program, *Maryland, *Nonpoint pollution sources, *Pennsylvania, *Virginia, *Water pollution control, Best management practices.

The Chesapeake Bay Agreement of 1983 established the framework for a cooperative effort among Virginia, Pennsylvania, Maryland, the District of Columbia, and the US EPA to address all sources of pollution in the Bay basin. This report describes the current programs to ameliorate nonpoint sources of pollution to the Bay that have been developed by the four jurisdictions in cooperation with other agencies; the achievements to date in terms of pollutant removal; and recommendations for future directions of the Bay program over the next several years. The report is organized into five chapters: Chapter 1, Nonpoint Source Strategy for Chesapeake Bay Restoration, provides an overview of Bay nonpoint source (NPS) problems and discusses the overall strategy for NPS control; Chapter 2, State Nonpoint Source Programs, describes the approaches that Virginia, Pennsylvania, Maryland and the District of Columbia are using to mitigate their NPS problems. The chapter describes the programs of these jurisdictions and cooperating agencies, with an emphasis on those aspects that are funded with EPA Chesapeake Bay Program grants; Chapter 3, Effectiveness of Best Management Practices, briefly summarizes the types of practices that are being used or studied by the Bay participants to manage or control nonpoint sources; Chapter 4, The Effect of Agricultural BMPs on Pollutant Loads Reaching the Bay, analyzes the available information on best management practices (BMPs) that have been implemented in 1985 and 1986; and, Chapter 5, Recommendations for Future Directions of the Chesapeake Bay NPS Program, presents recommendations and raises several issues for the Bay program over the next several years. (Lantz-PTT)
W91-07249

CODORUS CREEK PRIORITY WATER BODY SURVEY REPORT: WATER QUALITY STANDARDS REVIEW.
Susquehanna River Basin Commission, Harrisburg, PA. Resource Quality Management and Protection Div.
R. E. Edwards.
Publication No. 134, January 1991. Susquehanna River Basin Commission, Harrisburg, PA. 53p, 12 fig, 5 tab, 15 ref, append.

Descriptors: *Codorus Creek, *Pennsylvania, *Water pollution control, *Water pollution sources, *Water quality, *Water quality standards, Copper, Cyanide, Dissolved solids, Heavy metals, Lead, Standards, Water pollution effects, Water quality management, Zinc.

The Codorus Creek was classified as a priority water body by the Systems and Program Implementation Section, Bureau of Water Quality Management, Pennsylvania Department of Environmental Resources (PaDER). Wasteload allocation screening by PaDER indicated that Cu, Pb, Zn, and free CN were parameters of concern in Codorus Creek. Because of the possible impacts of toxic discharges, an intensive water quality survey of Codorus Creek was conducted on August 28-29, 1990, and September 5-6, 1990. Water quality standards were met for dissolved oxygen, pH, alkalinity and free CN at all stream stations measured on Codorus Creek. The chronic fish health criterion was exceeded for total Cu at River Mile (RM) 5.03 and for total Pb at RM 6.60 and RM 5.03. Highest values measured at Codorus Creek stream stations for free CN, total Cu, total Pb and total Zn were 1.0 microgm/L, 12.1 microgm/L, 4.0 microgm/L, and 21.6 microgm/L, respectively. The data indicated that some relationships exist between levels of toxic pollutants in Codorus Creek and the major dischargers. Significant inputs of total Zn can be attributed to the York City publicly owned treatment works (POTW)(5.71 lbs/day), the Springettsbury Township POTW (3.21 lbs/day), and the P.H. Glatfelter Company (2.64 lbs/day). The measured total Cu load from the P.H. Glatfelter Co. equalled 1.83 lbs/day. Although some of the dischargers studied have impacted the water quality on Codorus Creek, the trend analyses show that other sources may also be present. The total Zn and Cu concentrations measured in samples from Oil Creek were relatively high compared to concentrations observed on Codorus

Creek at RM 27.7. An unnamed tributary upstream of the USGS gage at West York had a total Pb concentration higher than stream concentrations on Codorus Creek. The lower reach of Codorus Creek contained concentrations of Cu and Pb two to four times higher than those sampled elsewhere on the Codorus Creek suggesting other unknown sources. (Lantz-PTT)
W91-07250

MODELCARE 90: CALIBRATION AND RELIABILITY IN GROUNDWATER MODELLING.
For primary bibliographic entry see Field 2F.
W91-07253

SIMULTANEOUS CALIBRATION OF FLOW AND TRANSPORT MODELS AND OPTIMIZATION OF REMEDIATION MEASURES.
Ecole Nationale des Ingenieurs des Travaux Ruraux et des Techniques Sanitaires, Strasbourg (France).
For primary bibliographic entry see Field 2F.
W91-07269

DELINEATION OF GROUNDWATER PROTECTION ZONES USING FORCED GRADIENT TRACER TESTS: A MODEL VALIDATION CASE STUDY.
Stuttgart Univ. (Germany, F.R.). Inst. fuer Wasserbau.
For primary bibliographic entry see Field 2F.
W91-07288

PROBABILISTIC COST EFFECTIVENESS IN AGRICULTURAL NONPOINT POLLUTION CONTROL.
Pennsylvania State Univ., University Park. Dept. of Agricultural Economics and Rural Sociology.
W. T. McSweeny, and J. S. Shortie.
Southern Journal of Agricultural Economics, Vol. 22, No. 1, p 95-104, 1990. 2 fig, 4 tab, 15 ref.

Descriptors: *Agricultural engineering, *Agriculture, *Cost analysis, *Nonpoint pollution sources, *Virginia, *Water pollution control, Economic aspects, Government supports, Groundwater pollution, Model studies, Rainfall, Resource management, Runoff, Soil erosion, Statistical analysis.

A probabilistic concept was used to evaluate the cost effectiveness of whole-farm pollution control plans. The case of a competitive, risk-neutral farm is considered, with a single pollutant assumed. Pollution runoff from the farm is a function of deterministic variables that the farmer controls in the production process and stochastic variables, such as rainfall. The study area for the testing of this model was the Nansemond River and Chuckatuck Creek watersheds, Virginia. An activity analysis model of the representative farm was developed to determine expected profit-maximizing farm plans with and without environmental constraints. The model was solved using linear and nonlinear procedures of MINOS. The cost and probabilistic effectiveness of three alternative restrictions (no-tillage, no-till except for peanuts, and prohibition of practices with annual average soil loss rates in excess of silt tolerance values on highly erodible land. Two main conclusions were drawn from the numerical analysis: reliability can be as important as reduction targets in designing farm plans for pollution control, and broad-axe prescriptions of 'appropriate' technology in the form of best management practices may perform poorly with respect to cost effectiveness. Government standards could be imposed on means and weighted variances and farmers could determine least-cost plans for meeting these standards (provided they receive technical assistance on the relationship between practices and the distribution of losses). Economic incentives offer another means for promoting cost effective planning at the farm level. The usefulness of a farm-level study is seen in designing controls, but a watershed model may often provide more useful information to planners regarding trade-offs across subsheds and tributaries. (Brunone-PTT)
W91-07362

INFLUENCE OF THE GLYCOLIPID-PRODUCING BACTERIUM RHODOCOCCUS ERYTHROPOLIS ON THE DEGRADATION OF A HYDROCARBON MIXTURE BY AN ORIGINAL SOIL POPULATION.
Technische Univ. Braunschweig (Germany, F.R.). Inst. fuer Biochemie und Biotechnologie.
E. Goclik, R. Muller-Hurtig, and F. Wagner.
Applied Microbiology and Biotechnology AMBIDG, Vol. 34, No. 1, p 122-126, 1990. 2 fig, 3 tab, 12 ref.

Descriptors: *Biodegradation, *Glycolipids, *Hydrocarbons, *Oil wastes, *Rhodococcus, *Soil bacteria, *Waste treatment, *Water pollution treatment, Carbon dioxide, Culture media, Culturing techniques, Degradation, Growth, Mineralization, Oxidation.

Experiments were undertaken to determine whether employing a starter culture of the bacterium Rhodococcus erythropolis that produces 6,6-trehalosedicorynomycolates could replace the addition of purified biosurfactant known to accelerate hydrocarbon degradation by an original soil population in a stirred reactor. The rate of degradation, degree of elimination of hydrocarbons, mineralization, and degree of oxidation were determined in order to assess the extent of degradation. Compared with degradation by soil microorganisms, only an acceleration of utilization of the hydrocarbons was observed in cultures of growing cells of R. erythropolis, although the effect of purified trehalosedicorynomycolates is not reached. Except for a higher degree of oxidation, a sufficient amount of trehalosedicorynomycolates bound to autoclaved biomass of R. erythropolis does not have any effect. (Author's abstract)
W91-07376

EFFECT OF SOIL/CONTAMINANT INTERACTIONS ON THE BIODEGRADATION OF NAPHTHALENE IN FLOODED SOIL UNDER DENITRIFYING CONDITIONS.
McGill Univ., Montreal (Quebec). Dept. of Civil Engineering.
B. Al-Bashir, T. Cseh, R. Leduc, and R. Samson.
Applied Microbiology and Biotechnology AMBIDG, Vol. 34, No. 3, p 414-419, December 1990. 2 fig, 1 tab, 20 ref.

Descriptors: *Biodegradation, *Bioremediation, *Naphthalenes, *Oil pollution, *Polycyclic aromatic hydrocarbons, *Soil contamination, Acidity, Denitrification, Flooding, Microbial degradation, Mineralization, Nitrates, Saturation, Soil organic matter, Sorption.

The mineralization of C14-labeled naphthalene was studied in pristine and oil-contaminated soil slurry (30% solids) under denitrifying conditions using a range of concentrations from below to above the aqueous phase saturation level. Results from sorption-desorption experiments indicated that naphthalene desorption was highly irreversible and decreased with an increase in the soil organic content, thus influencing the availability for microbial consumption. Under denitrifying conditions, the mineralization of naphthalene to CO2 occurred in parallel with the consumption of nitrate and an increase in pH from 7.0 to 8.6. When the initial substrate concentration was 50 ppm (close to the aqueous phase saturation level), about 90% of the total naphthalene was mineralized within 50 days, and a maximum mineralization rate of 1.3 ppm/day was achieved after a lag period of approximately 18 days. When added at concentrations higher than the aqueous phase saturation level (200 and 500 ppm), similar mineralization rates (1.8 ppm/day) occurred until about 50 ppm of the naphthalene was mineralized. After that the mineralization rates decreased logarithmically to a minimum of 0.24 ppm/day for the rest of the 160 days of the experiments. This study clearly shows the potential of denitrifying conditions for the biodegradation of low molecular weight polycyclic aromatic hydrocarbons. (Author's abstract)
W91-07380

EMERGING PRIORITIES FOR AGRICULTURAL RESEARCH IN THE 1990S.
Proceedings and Minutes of the 37th Annual Meeting of Agricultural Research Institute, October 12-14, 1988, Washington, DC. Agricultural Research Institute, Bethesda. 1988. 265p.

Descriptors: *Agricultural Research Institute, *Agriculture, *Institutions, *Symposium, *Washington, Air quality, Food safety, Management, Pesticides, Water quality.

Proceedings and minutes of the thirty-seventh annual meeting of the Agricultural Research Institute (ARI) held in Washington, D. C. on October 12-14, 1988 are presented. The ARI was organized in 1951 by industrial scientists as a supporting institution for the Agricultural Board of the National Academy of Sciences/National Research Council to identify and promote the kinds of research and policies needed to ensure the best long-term utilization and management of agricultural resources for the national welfare. This meeting addressed major issues in agriculture which included pesticide use, air quality, water quality, and food safety and quality. Cutting across all of these concerns are issues of agricultural competitiveness and appropriate research strategies. (See W91-07446 thru W91-07444) (Medina-PTT)
W91-07443

IMPROVING ON-TARGET PLACEMENT OF PESTICIDES.
Ohio State Univ., Wooster. Lab. for Pest Control Application Technology.
F. R. Hall.
IN: Emerging Priorities for Agricultural Research in the 1990s. Agricultural Research Institute, Bethesda. 1988. p 9-16. 1 fig, 11 ref.

Descriptors: *Agricultural chemicals, *Path of pollutants, *Pesticide drift, *Pesticide toxicity, *Pesticides, *Water pollution prevention, Air pollution, Food chains, Water quality.

Since 1984, the Agriculture Research Institute (ARI) has been concerned with pesticides in the environment but little concerned with how these pesticides are delivered to the environment. Today, questions are asked about the food chain, pesticides in foods, toxic waste dumps, and the billion dollar blunder (lack of sufficient sprayer calibration). Thus the agricultural community is faced with impact pressures from high technology agriculture focused on water quality, worker safety, ethics, labor, endangered species, air quality, waste management, small farm strategies, best management practices, etc. A recent meeting was held by the ARI to develop an Implementation Plan for improving the placement efficiency of agrochemicals. The conference attendees were to: (1) identify key events dictating current and future programs (regulatory and public perceptions), and educational successes and opportunities within the public and private sectors; and (2) to develop an implementation plan which will stimulate innovative activities and promote a coordinated multidisciplinary strategy for a more rational, scientific utilization of agrochemicals for the 1990's. It was determined that major objectives should be to (1) improve and develop new concepts of returnable packaging and standardize containers; and (2) develop a training program and set up a national network to 'transfer the technology'. (See also W91-07443) (Medina-PTT)
W91-07444

CHANGING ATMOSPHERE: IMPLICATIONS FOR AGRICULTURE.
Agricultural Research Service, Beltsville, MD. Climate Stress Lab.
D. T. Krizek.
IN: Emerging Priorities for Agricultural Research in the 1990s. Agricultural Research Institute, Bethesda. 1988. p 21-35. 3 tab, 31 ref.

Descriptors: *Air pollution, *Global warming, *Greenhouse effect, Agriculture, Carbon dioxide, Chlorofluorocarbons, Halons, Methyl chloroform, Nitrous oxide, Ozone, Radioactivity, Ultraviolet radiation.

During the past 30 years, the chemistry of the atmosphere has changed dramatically because of a build-up in carbon dioxide, nitrous oxide, methane, chlorofluorocarbons, methyl chloroform, halons, and other trace gases. Because of the radioactive properties of these contaminants, there is growing concern that accumulation of these greenhouse gases will contribute to global warming and other adverse changes in climate. There is also concern that decreases in stratospheric ozone concentration will increase the level of biologically effective radiation in the 28-320 nm (UV-B) region. Such changes in the atmosphere could have a significant impact on production of crops and natural ecosystems. Single and multiple-factor studies are needed to assess the agricultural impact of increased levels of CO-2, air pollutants, UV-B radiation, drought, and high temperature stress and to determine the mechanisms of tolerance or adaptation to these stress factors. Policy options available to reduce emissions of green house gases include making changes in energy production and use, developing environmentally safe substitutes, altering methods for agricultural production, increasing reforestation, and changing land management practices. Any overall solution will require international cooperation among many nations and significant reductions in many sources. (See also W91-07443) (Author's abstract)
W91-07445

AMELIORATION OF SURFACE WATER ACIDITY BY CATCHMENT MANAGEMENT.
Institute of Terrestrial Ecology, Grange-over-Sands (England). Merlewood Research Station.
M. Hornung, S. J. Brown, and A. Ranson.
IN: Acid Waters in Wales. Monographiae Biologicae Volume 66. Kluwer Academic Publishers, Norwell, Massachusetts. 1990. p 311-328. 4 fig, 34 ref.

Descriptors: *Acid rain effects, *Acid streams, *Acidification, *Acidity, *Wales, *Watershed management, Air pollution, Buffer capacity, Coniferous forests, Drainage patterns, Economic aspects, Emission control, Forestry, Liming, Neutralization, Reforestation, Soil amendments, Soil chemistry, Streams, Sumps, Surface water.

Amelioration of surface water acidity in upland Wales will almost certainly involve a combination of emission reductions and direct intervention in catchment management. Possible modifications to catchment management are outlined. Topics include: (1) modification of catchment vegetation; (2) modifications to soil chemistry by addition of neutralizing materials, burning, and drainage; and (3) modifications to catchment hydrology. Results are presented from current catchment management experiments being conducted in Wales which include: standard agricultural land improvement, surface liming, forestry ploughing, conifer forest treatments, bankside clearance and liming, and intensive liming on an unplanted area within a forest. It is concluded that liming of stream catchments can lead to a reduction in surface water acidity. Finely ground materials should be used to obtain a rapid response. Treatment of a whole catchment, by surface liming, produces a reduction in acidity but the most cost effective treatment might well be liming of source areas, which may form only a small part of the catchment, at high rates, e.g. 25-30 t/ha. Large-scale felling of forests to reduce stream acidity is not practical and may, on sensitive sites, cause an initial increase in acidity and/or aluminum concentrations. Decisions on the advisability of afforestation on sensitive sites should be made before planting, or after normal harvesting. Modified ploughing and drainage techniques and modified design of drainage schemes in forestry plantations reduce the impact of site preparation on surface water acidity. Ripping and digging of sumps to ensure deep penetration, and increased buffering of drainage waters are unlikely to be effective at most upland Welsh sites. (See also W91-07472) (Agostine-PTT)
W91-07491

ABATEMENT OF ATMOSPHERIC EMISSIONS IN NORTH AMERICA: PROGRESS TO DATE AND PROMISE FOR THE FUTURE.
Southern California Edison Co., Rosemead.
E. C. Ellis, R. E. Erbes, and J. K. Grott.
IN: Acidic Precipitation, Vol. 3: Sources, Deposition, and Canopy Interactions. Advances in Environmental Science. Springer-Verlag New York, Inc., New York. 1990. p 285-322. 5 fig, 9 tab, 55 ref.

Descriptors: *Acid rain, *Acid rain effects, *Acidification, *Air pollution, *Emission control, *North America, *Water pollution control, Atmosphere, Canada, Economic aspects, Industrial wastes, Nitrogen oxides, Planning, Political aspects, Powerplants, Reviews.

Much progress has been made in acidic rain abatement in North America. This progress is examined with a focus on man-made emissions of sulfur dioxide and nitrogen oxides (NO and NO2) that contribute to acidic deposition. A review of U.S. historical trends of SO2 and nitrogen oxides emissions since 1900 and projections of future emissions through the end of this century show emissions of SO2 decreasing from a peak in 1970 of 29 Tg/yr to about 26 Tg/yr, but nitrogen oxides emissions continuing an upward trend to about 25 Tg/yr. In Canada, SO2, NO and NO2 emissions are less than 20% of those in the United States, and the trends are similar, with SO2 showing future decreases and NO and NO2 continuing to increase. Future industry in North America is expected to emit much lower levels of SO2, NO, and NO2. Technology is also available to limit nitrogen oxides emissions from future motor vehicles. Recent acidic deposition legislation in the U.S. Congress to reduce electric utility and industrial emissions of SO2 by 9 to 13 Tg/yr is reviewed. The estimates of the cost to implement the proposals range from $2 billion to $23 billion over a 5-year period. Retrofitting existing utility and industrial boilers for maximum SO2, NO, and NO2 reduction carries the highest price tag. Several environmental policy options are explored for preventing emission increases and also promoting decreases in future emissions of SO2, NO, and NO2 in North America. Focus on nitrogen oxides emissions may be critical because population growth could cause significant increases in NO and NO2 from motor vehicle use. (See also W91-07513) (Author's abstract)
W91-07519

BIOLOGICAL STATUS QUO IN THE LOWER WUPPER (DER BIOLOGISCHE STATUS QUO DER UNTEREN WUPPER).
Bayer A.G., Leverkusen (Germany, F.R.). Umweltschutz/Analytik.
N. Caspers, and H. Spaeh.
Zeitschrift fuer Wasser- und Abwasser-Forschung ZWABAQ, Vol. 23, No. 5, p 199-204, October 1990, 2 fig, 5 tab, 9 ref. English summary.

Descriptors: *Germany, *River restoration, *Stream pollution, *Water pollution control, *Water pollution treatment, *Water quality trends, *Wupper River, Dam effects, Fish food organisms, Fish populations, Industrial development, Waste treatment, Water pollution sources.

After more than a hundred years of extreme pollution, the ecosystem of the lower Wupper River, in the heavily-industrialized area of Westphalia, Germany, is now showing encouraging signs of recovery. This is the direct result of carefully-targeted wastewater-treatment programs in industry. The previously high levels of toxicity (as determined by Daphnia bioassay) have been ameliorated and there has been a corresponding increase in the diversity of benthic invertebrate species, especially of insect larvae. Thus, since about 1980, a plentiful fauna of fish-food organisms has been building up; this in turn has facilitated the stabilization of a fish fauna. However, this fauna continues to be subject to detrimental influences--such as dams which restrict fish movements, inadequate sewer systems (such as those of the cities of Wuppertal and Solingen), and the input of enriching substances from the outfalls of municipal sewage plants. Through the combined efforts of all users of the lower Wupper, an integrated restoration project (as proposed in the existing management plan) might eventually allow the permanent establishment of a water-quality classification of only 'moderately polluted'. (King-PTT)
W91-07546

EVALUATING GAC FOR TRIHALOMETHANE CONTROL.
Southern California Metropolitan Water District, Los Angeles.
For primary bibliographic entry see Field 5F.
W91-07604

KINETICS OF CHLORINATED HYDROCARBON DEGRADATION BY METHYLOSINUS TRICHOSPORIUM OB3B AND TOXICITY OF TRICHLOROETHYLENE.
Groningen Rijksuniversiteit (Netherlands). Dept. of Biochemistry.
For primary bibliographic entry see Field 5B.
W91-07640

AEROBIC BIODEGRADATION POTENTIAL OF SUBSURFACE MICROORGANISMS FROM JET FUEL-CONTAMINATED AQUIFER.
Geological Survey, Columbia, SC.
For primary bibliographic entry see Field 5B.
W91-07641

DECHLORINATION OF CHLOROCATECHOLS BY STABLE ENRICHMENT CULTURES OF ANAEROBIC BACTERIA.
Swedish Environmental Research Inst., Stockholm.
For primary bibliographic entry see Field 5B.
W91-07642

EFFECTS OF TOXICITY, AERATION, AND REDUCTANT SUPPLY ON TRICHLOROETHYLENE TRANSFORMATION BY A MIXED METHANOTROPHIC CULTURE.
California Univ., Berkeley. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W91-07646

INFLUENCE OF ENDOGENOUS AND EXOGENOUS ELECTRON DONORS AND TRICHLOROETHYLENE OXIDATION TOXICITY ON TRICHLOROETHYLENE OXIDATION BY METHANOTROPHIC CULTURES FROM A GROUNDWATER AQUIFER.
Stanford Univ., CA. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W91-07647

PHYSIOLOGICAL DIVERSITY AND DISTRIBUTIONS OF HETEROTROPHIC BACTERIA IN DEEP CRETACEOUS SEDIMENTS OF THE ATLANTIC COASTAL PLAIN.
Battelle Pacific Northwest Labs., Richland, WA.
J. K. Fredrickson, D. L. Balkwill, J. M. Zachara, S. W. Li, and F. J. Brockman.
Applied and Environmental Microbiology AEMIDF, Vol. 57, No. 1, p 402-411, February 1991, 1 fig, 8 tab, 28 ref. Department of Energy contract DE AC06-76RLO 1830.

Descriptors: *Biodegradation, *Bioremediation, *Cleanup, *Groundwater pollution, *Heterotrophic bacteria, *In situ treatment, *Species composition, Aerobic bacteria, Biological studies, Biotransformation, Culturing techniques.

A series of 23 intact core segments was obtained from two distinct deep subsurface geological formations, the Middendorf and the Cape Fear formations, underlying the southeastern coastal plain of South Carolina. The Middendorf formation in this region consists of permeable, saturated, sandy sediments: the Cape Fear formation consists mainly of less permeable sediments. The core segments were separated by vertical distances ranging from several centimeters to 48 meters. Aerobic chemohetrotrophic bacteria were enumerated in a dilute medium, and populations ranged from 3.1 to 6.4 log CFU per gram of sediment in the Middendorf cores and from below detection to 4.3 log CFU per gram in the Cape Fear cores. A total of 198

morphologically distinct colony types were isolated, purified, and subjected to 108 different physiological measurements. The isolates from the two formations were distinct (i.e., they produced substantially different response patterns to the various physiological measurements), as were those in different core samples from the same formation. Cluster analysis revealed 21 different biotypes based on similarities of 75% or higher in response patterns to 21 physiological assays. One biotype contained 57 (29%) of the subsurface isolates, 10 biotypes contained 5 or more isolates, and the remainder had 4 or fewer. The organic compounds that were most commonly metabolized by the subsurface bacteria included Tween 40 (85%) and beta-hydroxybuteric acid (60%). Organic acids, in general, were also commonly metabolized by the subsurface bacteria. Isolates from the Cape Fear core segments were capable of metabolizing a higher percentage of the substrates than were bacteria isolated from the Middendorf formation. Although the heterogeneous distributions of bacteria in deep subsurface sediments may make it difficult to use aquifer microorganisms to predict in situ biotransformation rates, the diversity of the physiological properties of these organisms offers promise for in situ remediation of contaminants. (Author's abstract)
W91-07650

EFFECTS OF 2,4-DICHLOROPHENOL, A METABOLITE OF A GENETICALLY ENGINEERED BACTERIUM, AND 2,4,-DICHLOROPHENOXYACETATE ON SOME MICROORGANISM-MEDIATED ECOLOGICAL PROCESSES IN SOIL.
Corvallis Environmental Research Lab., OR.
K. A. Short, J. D. Doyle, R. J. King, R. J. Seidler, and G. Stotzky.
Applied and Environmental Microbiology AEMIDF, Vol. 57, No. 2, p 412-418, February 1991, 4 fig, 2 tab, 34 ref.

Descriptors: *Biodegradation, *Bioremediation, *Chlorinated hydrocarbons, *Cleanup, *Genetic engineering, *In situ treatment, *Pseudomonas, *Soil contamination, Bacteria, Dechlorination, Decontamination, Degradation products, Enzymes, Gas chromatography, Mass spectrometry, Metabolites, Plasmids.

In order to test the efficacy of pRO301, a plasmid which encodes for the degradation of 2,4-dichlorophenoxyacetate (2,4-D) as a potential bioremediator of contaminated soil systems, a genetically engineered microorganism, Pseudomonas putida PPO301(pRO103), and the plasmidless parent strain, PPO301, were added at approximately 10,000,000 CFU/g of soil amended with 500 ppm of 2,4-D (500 micrograms/gram). The degradation of 2,4-D and the accumulation of a single metabolite, identified by gas chromatography-mass spectrophotometry as 2,4-dichlorophenol (2,4-DCP), occurred only in soil inoculated with PPO301(pRO103), wherein 2,4-DCP accumulated to >70 ppm for 5 weeks and the concentration of 2,4-D was reduced to <100 ppm. Coincident with the accumulation of 2,4-DCP was a >400-fold decline in the numbers of fungal propagules and a marked reduction in the rate of CO2 evolution, whereas 2,4-D did not depress either fungal propagules or respiration of the soil microbiota. 2,4-DCP did not appear to depress the numbers of total heterotrophic, sporeforming, or chitin-utilizing bacteria. In vitro and in situ assays conducted with 2,4-DCP and fungal isolates from the soil demonstrated that 2,4-DCP was toxic to fungal propagules at concentrations below those detected in the soil. (Author's abstract)
W91-07651

DEGRADATION OF TOLUENE AND M-XYLENE AND TRANSFORMATION OF O-XYLENE BY DENITRIFYING ENRICHMENT CULTURES.
New York Univ. Medical Center, NY. Dept. of Microbiology.
P. J. Evans, D. T. Mang, and L. Y. Young.
Applied and Environmental Microbiology AEMIDF, Vol. 57, No. 1, p 450-454, February 1991, 2 fig, 5 tab, 25 ref. NIEHS grant ES 04895 and NIAID grant 5T32 AI-07180.

Descriptors: *Biodegradation, *Bioremediation, *Biotransformation, *Fate of pollutants, *Toluene, *Xylenes, Anaerobic bacteria, Culturing techniques, Denitrification, Enrichment, Groundwater pollution, Sediment contamination, Sludge, Soil contamination, Wastewater.

Seven different sources of inocula that included sediments, contaminated soils, groundwater, process effluent, and sludge were used to establish enrichment cultures of denitrifying bacteria on benzene, toluene, and xylenes in the absence of molecular oxygen. All of the enrichment cultures demonstrated complete depletion of toluene and partial depletion of ortho-xylene within 3 months of inoculation. The depletion of ortho-xylene was correlated to and dependent on the metabolism of toluene. No losses of benzene, para-xylene, or meta-xylene were observed in these initial enrichment cultures. However, meta-xylene was degraded by a subculture that was incubated on meta-xylene alone. Complete carbon, nitrogen, and electron balances were determined for the degradation of toluene and meta-xylene. These balances showed that these compounds were mineralized with greater than 50% conversion to CO2 and significant assimilation into biomass. Additionally, the oxidation of these compounds was shown to be dependent on nitrate reduction and denitrification. These microbial degradative capabilities appear to be widespread, since the widely varied inoculum sources all yielded similar results. (Author's abstract)
W91-07652

HAZARDOUS AND INDUSTRIAL WASTES: PROCEEDINGS OF THE 22ND MID-ATLANTIC INDUSTRIAL WASTE CONFERENCE.
For primary bibliographic entry see Field 5D.
W91-07662

REGULATING THE POLLUTION OF GROUND WATER: RESPONDING TO THE NPDES DISCHARGE TO GROUND WATER PERMIT FEE REGULATIONS.
Integrated Data Technologies, Inc., Philadelphia, PA.
For primary bibliographic entry see Field 2F.
W91-07663

IMPACT OF LAND DISPOSAL RESTRICTIONS ON HAZARDOUS WASTE SITE CLEANUPS.
Eckenfelder, Inc., Mahwah, NJ. Waste Management Div.
For primary bibliographic entry see Field 5E.
W91-07664

RCRA FACILITY INVESTIGATION AND CORRECTIVE MEASURES STUDY PROGRAM: CASE STUDIES.
Weston (Roy F.), Inc., West Chester, PA.
H. G. Byer, and R. J. Buchanan.
IN: Hazardous and Industrial Wastes: Proceedings of the 22nd Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 43-53. 1 fig, 1 tab, 2 ref.

Descriptors: *Cleanup operations, *Economic aspects, *Groundwater pollution, *Hazardous wastes, *Resource Conservation and Recovery Act, *Site remediation, Industrial wastes, Regulations, Restoration, Site assessment, Solid waste disposal, Wastewater disposal.

The Resource Conservation and Recovery Act (RCRA) Facility Investigation and Corrective Measures Study program was mandated by the 1984 Amendments to RCRA. The U.S. EPA assessment procedure impacts directly on many industrial plants. Section 3004(u) of the Hazardous and Solid Waste Amendments of 1984 to RCRA requires that EPA provide an assessment of old Solid Waste Management Units located on RCRA facilities and seeking RCRA hazardous waste permits. Certain solid waste management units have been shown to be leaking and adversely impacting the environment. One of the most troublesome aspects of the RCRA Facility Investigation and Corrective Measures Study process is that most activity is usually undertaken as part of a negotiated consent order or through the EPA permit process. Ultimately, the industry charged with implementing the regulations also will be dealing with the state Regulatory Agency in addition to the EPA. In one case, a facility was accused of contaminating the area groundwater through the disposal of solvents and metals into an unlined lagoon in use prior to the Korean Conflict. The facility detection monitoring program showed a significant increase in the downgradient volatile organic chemical concentrations emanating from solid waste management units onsite. The whole area is an industrial area, developed on top of fill material, with automobile reclamation businesses, an old municipal landfill, and other commercial enterprises located between the site in question and three municipal wells on the other side of a high volume river and one of its tributaries. The U.S. EPA wanted lagoon closure activities started immediately, including a closure plant to be reviewed by both federal and state agencies. The regulatory impact and cost impact on industrial plants are just now being realized. Cost can range over a million dollars and not include any interim corrective measures or any legal or technical negotiations industry may deal with prior to starting investigative work. Additionally, the cost for implementation of such corrective measures may be in the millions of dollars. (See also W91-07662) (Mertz-PTT)
W91-07665

IN-SITU CHEMICAL OXIDATION OF HAZARDOUS COMPOUNDS IN SOIL.
Drexel Univ., Philadelphia, PA. Environmental Studies Inst.
J. X. Ravikumar, and M. D. Gurol.
IN: Hazardous and Industrial Wastes: Proceedings of the 22nd Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 57-65. 6 fig, 13 ref.

Descriptors: *Chemical treatment, *Cleanup, *Hazardous wastes, *In situ treatment, *Oxidation, *Soil treatment, *Water pollution treatment, Chlorinated aromatic compounds, Groundwater pollution, Hydrogen peroxide, Soil contamination, Vadose zone.

Inadequate or improper disposal of hazardous chemicals has resulted in considerable contamination of soil and groundwater. Concern persists over the contamination of the vadose zone, the region of primary impact of a spill, for fear of contamination of the underlying aquifer due to infiltration. Although adsorption onto soil surfaces or retention in the pores can temporarily mitigate the immediate danger of contamination of the groundwater, it is desirable to remediate the soils before the contaminants can migrate and contaminate any aquifer. Biological treatment can transform some of these compounds to innocuous end products. Many compounds, however, persist either due to the low rate of biodegradation or recalcitrance. The efficacy of chemical oxidation for the treatment of biorefractory chemicals in soil was examined. Hydrogen peroxide was utilized as the chemical oxidant. Pentachlorophenol has examined as a model compound in soil-packed columns in the laboratory. Results showed that pentachlorophenol adsorbed on soil was oxidized by the application of hydrogen peroxide solutions onto soil. 1.55 millimoles of hydrogen peroxide was able to oxidize 27% of pentachlorophenol from soils that had an initial concentration of 59 mg/kg in a column that contained 2.4 kg of soil. As hydrogen peroxide alone cannot oxidize pentachlorophenol, and since chemical oxidation of the pentachlorophenol in soil was occurring, it was perceived that hydrogen peroxide was decomposed to hydroxyl radicals by the catalytic effect of iron in the soil. Hydroxyl radicals should be responsible for the oxidation of pentachlorophenol. Pentachlorophenol adsorbed on soil can leach out at significant levels. The binding of the organic pentachlorophenol to the soil is generally a function of the soil organic content, with increasing

affinity to the soils with increasing soil organic content. The soil used in this study was very low in organic matter, hence pentachlorophenol was desorbed readily from the soil. (See also W91-07662) (Mertz-PTT)
W91-07666

USE OF A SITE HISTORY AS A PRELIMINARY STEP IN THE SITE ASSESSMENT OF A COMPLEX INDUSTRIAL FACILITY: THE POMPTON LAKES WORKS OF E. I. DU PONT DE NEMOURS & COMPANY.
Du Pont de Nemours (E.I.) and Co., Pompton Lakes, NJ.
C. M. Olson, and M. L. Monserrate.
IN: Hazardous and Industrial Wastes: Proceedings of the 22nd Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 103-117. 6 fig.

Descriptors: *Cleanup, *Explosives, *Industrial wastes, *New Jersey, *On-site investigations, *Site histories, *Site remediation, Data collections, Hazardous wastes, Land disposal, Pompton Lake Site, Regulations, Rehabilitation, Waste disposal.

Since 1986, Du Pont's Pompton Lakes Works and its predecessors have manufactured a variety of explosives. This same time period has seen regulations governing waste handling and disposal go from nonexistent to stringent, requiring assessment and reversal of the effects of past practices. To comply with the terms of an Administrative Consent Order between Du Pont and the New Jersey Department of Environmental Protection, Du Pont is performing a remedial investigation, feasibility study and remedial action at Pompton Lakes Works. This process is complex for an industrial facility with a combination of: numerous potential waste disposal areas, a long operating history and little knowledge of past waste disposal practices. To identify areas with a potential of contamination and to eliminate those areas without a potential for contamination, an operational site history was prepared. A three-part process was used to obtain information for the history: a search of written records, interviews with current and retired personnel and a reconnaissance of the plant site. The process was interactive. As new information surfaced, it was compared with previous information and people were interviewed again or maps adjusted. All information was independently corroborated by at least two interviewees or by one interviewee agreeing with written records. The final history included a chronology and maps of the facilities, plant processed and plant waste sites, all supported by extensive appendices of tables, maps and photos. The waste site history showed 7 identifiable eras between 1886 and the present and 13 discrete operational processes. Operational processes frequently overlapped eras, and disposal locations for each waste stream in each era were identified. In this way, 119 suspected waste areas, their surface area and possible contaminants were identified. The areas range in size from point sources to more than 40 acres with ages in excess of 90 years. (See also W91-07662) (Author's abstract)
W91-07670

IN-SITU REMEDIATION OF A CHLORINATED SOLVENT CONTAMINANT PLUME USING VACUUM EXTRACTION TECHNOLOGY.
Dunn Geoscience Corp., Parsippany, NJ.
C. A. Hayes, J. Duncan, and T. M. Johnson.
IN: Hazardous and Industrial Wastes: Proceedings of the 22nd Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 269-289. 18 fig, 5 tab.

Descriptors: *Cleanup operations, *Groundwater pollution, *In situ treatment, *Site remediation, *Volatile organic compounds, *Water pollution treatment, Cleanup, Groundwater contamination, Groundwater management, On-site investigations, Separation techniques, Vacuum extraction, Vadose zone.

A pilot-scale test of the Terra Vac Vacuum Extraction System was carried out at an actual hazardous waste site located in New York State. The site had been previously used as a salvage area for scrap metal, a concrete batch plant, and an oil storage tank farm. An environmental investigation determined that a small portion of the site contained soil and groundwater contaminated with volatile organic compounds. The ability of the Vacuum Extraction System to remove volatile organic compounds from soil pores, soils, and groundwater at the site was investigated during the pilot study. Because the groundwater was only 3-4 feet below the surface, while contamination was believed to exist at depths of up to 20 feet below the surface, a dual extraction system was used at the site. This involved pumping groundwater to depress the water table at the site and create an artificial vadose zone. Water and vapor were therefore both being withdrawn: hence the term dual extraction. In was shown that the site can effectively be dewatered if a containment wall is utilized. The trenches were also vital in the dewatering of the site for the pilot study. Additional deep wells, however, could also be utilized in future remediation activities at the site. The importance of dewatering the site required that this activity be given the highest priority, therefore, all extraction wells were used at one time and the radius of influence of the extraction wells was never determined. This is a serious short coming if the Vacuum Extraction System is to be used as a full-scale remediation technology. Another shortcoming is that individual wellhead gas samples were not taken. It can be concluded that once the soil has been dewatered, vapor flow through the soils is possible and vacuum extraction is an effective remedial option for this site. The trenches, in particular, seemed to be effective. It would be advisable to investigate less costly and time consuming methods of treating the extracted vapor and groundwater. (See also W91-07662) (Mertz-PTT)
W91-07681

CASE HISTORY: MITIGATION OF GASOLINE VAPOR MIGRATION INTO PRIVATE RESIDENCE.
Duffield Associates, Inc., Wilmington, DE.
J. M. Bross, and K. L. Allen.
IN: Hazardous and Industrial Wastes: Proceedings of the 22nd Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 290-302. 5 fig.

Descriptors: *Cleanup operations, *Gasoline, *Groundwater pollution, *Path of pollutants, *Site remediation, *Vapor transport, Cleanup, Delaware, Groundwater, Underground storage tanks, Vaporization.

In winter of 1989, groundwater in the vicinity of a reported gasoline underground storage tank site in Northern New Castle County, Delaware was suspected of being contaminated by gasoline. Preliminary investigation was performed by the State of Delaware Department of Natural Resources and Environmental Control Underground Storage Tank Branch as a result of reports of gasoline vapors in a private residence located near the site. This investigation indicated the presence of potentially hazardous levels of gasoline vapors in the basement of the home, requiring emergency evacuation of the residents. After conducting hydrogeologic, geotechnical and structural evaluations, a multi-tiered remedial program was developed to mitigate gasoline vapor migration into the house. To minimize future maintenance associated with the site, only passive remedial options were considered. An underdrain or interceptor trench system and a petroleum hydrocarbon resistant geomembrane barrier were installed hydraulically upgradient from the affected residence to divert petroleum hydrocarbon contaminated groundwater away from the house and into the public sanitary sewer system. Vapors were passively vented from the installed interceptor trench and reconstruction of the basement floor drain system, minimized the potential for vapor migration into the residence. Open voids and cracks in the basement's masonry walls were sealed. The access from the basement to the earthen-floored crawlspace was sealed and a concrete slab on the crawlspace was poured. To increase the probability of success in mitigating vapor migration into the residence, cost effective redundancy was built into the selection of remedial actions and design of the system. On-going monitoring of the mitigation system and conditions at the affected residence has indicated that this multifaceted approach has, to date, been successful in addressing the vapor problem and allowing the residents to return to their home while other remedial investigations continue in the surrounding neighborhood. (See also W91-07662) (Mertz-PTT)
W91-07682

MAJOR REMEDIATION: REMOVAL AND RECOVERY OF TCE FROM SOIL AND GROUNDWATER.
Dames and Moore, Willow Grove, PA.
E. C. Lindhult, M. D. Tischuk, and R. D. Moose.
IN: Hazardous and Industrial Wastes: Proceedings of the 22nd Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 303-320. 3 fig.

Descriptors: *Cleanup, *Cleanup operations, *Groundwater pollution, *Site remediation, *Soil contamination, *Trichloroethylene, *Waste recovery, Activated carbon, Groundwater management, Hazardous wastes, Industrial wastes, Vacuum extraction.

During a pre-transfer property investigation at an industrial facility, significant trichloroethylene contamination was detected in the subsurface. Further investigation detected a free-product layer was as great as 6 feet. The quantity of free-product trichloroethylene perched on the silt layer has been estimated at several thousand gallons. The state regulatory agency was notified of the situation. Additional groundwater monitoring wells were placed into all three aquifer systems (shallow overburden, confined overburden, and bedrock). Data for these wells, including pumping tests, were used to better characterize the hydrogeology. Groundwater analysis from all three aquifers indicated trichloroethylene concentrations exceeding 10 mg/L. After review of the pumping test data and the groundwater and soil laboratory analyses, a preliminary treatment design was prepared and submitted to the regulatory agency. Regulatory approval was received for the installation of a treatment system to remediate the on-site contamination. The system includes groundwater extraction from the bedrock, shallow, and confined overburden wells using pneumatic and electrical pumps. Vacuum extraction of the contaminated soil gas will be performed by drawing air through the shallow recovery well screens. The proposed groundwater treatment program includes a liquid-liquid separator to remove free-product trichloroethylene from groundwater in the overburden aquifer. A portion of the flow will be passed through disposable granular activated carbon units for polychlorinated biphenyls removal. An aeration tank, flocculator, Lamella clarifier, and filter press are included in the design to remove elevated concentrations of natural iron from the groundwater. All groundwater will then be treated by air stripping towers and a majority of the effluent will be polished by granular activated carbon units. A portion of the effluent will be percolated into the ground through recharge trenches, hydraulically upgradient of the shallow recovery wells. The waste air stream, including soil gas removed from the vadose zone through the use of vacuum extraction, will be polished using steam-regenerable vapor-phase granular activated carbon units. (See also W91-07662) (Author's abstract)
W91-07683

REMEDIATION OF A CONTAMINATED DRAINAGE DITCH IN PROXIMITY TO AN ACTIVE RAILROAD.
Woodward-Clyde Consultants, Plymouth Meeting, PA.
R. M. Coad, and H. S. Laird.
IN: Hazardous and Industrial Wastes: Proceedings of the 22nd Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 321-336. 4 fig, 4 tab, 4 ref.

Descriptors: *Cleanup operations, *Drainage ditches, *Path of pollutants, *Site remediation,

*Waste disposal, Environmental protection, Excavation, Grouting, Hazardous wastes, Railroads, Waste management.

An investigation of a small uncontrolled waste site was begun early in the 1980's to evaluate whether contaminants were being leached by surface water infiltration and subsequently discharged into nearby surface drainage ditches via stormwater drains that transect the site. Tests of ditch water runoff adjacent to, and downstream from, the site exhibited elevated concentrations of the same contaminants found in high concentrations on site. Further testing showed that the sediments within and adjacent to the ditch exhibited contaminant concentrations at the same levels as at the site. An interim remedy, to reduce the potential risk to human health and the environment, is intended to be effective long enough to allow completion of an overall remedial investigation and feasibility. The alternatives that were considered included limited excavation and replacement with a precast stone and grouted mat system. In the limited excavation and replacement alternative, the highly contaminated materials would be excavated, contained, and disposed of, and a silty/clay or clayey/silt fill would replace the contaminated materials. Another alternative, a precast stone and grouted mat system for erosion control would use a geotextile as a separation medium between the existing soils and the cover material. The choice of either of these alternatives would require the ditch to be excavated to restore a gradient that would minimize the ponding of water in the ditch. Minimization of the amount of excavated materials was a constraint on the design due to the high cost of transportation and disposal of these materials in a hazardous waste landfill and impact of the land disposal restrictions. Therefore, the precast stone/grouted mat alternative was selected. The chosen design incorporates engineering requirements due to proximity to an active railroad, construction constraints resulting from hazardous waste storage and disposal regulations, and environmental considerations. The remedy is designed to effectively reduce the erosion of contaminated sediment and hence its contribution to environmental degradation. (See also W91-07662) (Mertz-PTT)
W91-07684

TREATABILITY OF A FRENCH INDUSTRIAL LANDFILL LEACHATE USING A BIOLOGICAL TRICKLING FILTER.
Institut National des Sciences Appliquees de Lyon, Villeurbanne (France). Lab. de Chimie et Genie de l'Environnement.
For primary bibliographic entry see Field 5D.
W91-07687

BIOLOGICAL LAND TREATMENT OF DIESEL FUEL CONTAMINATED SOIL, A CASE STUDY.
O.H.M. Remediation Services Corp., Princeton, NJ.
M. A. Troy, B. P. Greenwald, S. W. Berry, T. Price, and P. M. Woodhull.
IN: Hazardous and Industrial Wastes: Proceedings of the 22nd Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 425-437. 3 fig, 3 tab, 5 ref.

Descriptors: *Biological treatment, *Cleanup operations, *Fuel, *Land disposal, *Oil spills, *Site remediation, *Soil contamination, *Soil treatment, Cost analysis, Hydrogen ion concentration, Liners, Moisture content, New Jersey, Nitrogen, Organic carbon, Phosphorus.

Biological land treatment techniques were employed for the cleanup of approximately 8400 gallons of diesel fuel that spilled from a storage tank at a warehouse in New Jersey. Biological land treatment of diesel fuel focuses on the breakdown of the hydrocarbon fractions by aerobic microorganisms in the top layers of the soil where oxygen is available. Metabolism by these microorganisms ultimately reduces the hydrocarbons to CO2, water and biomass. An area adjacent to the client's warehouse was chosen as the site for the biological land treatment cell. This area was initially altered to optimize the bioremediation operation by either excavating and/or filling in the site to provide a level area with a slope of approximately 2%. A two-foot high berm was placed around the cell to control the surrounding runoff. A synthetic liner was then placed over the cell floor. Drainage tile was placed on the floor of the treatment cell. Earthmoving equipment and hauling trucks were used to move the contaminated soil to the treatment facility. A backhoe was used to spread the soil into a level layer approximately 14-18 inches thick. Total organic carbon, pH, moisture content, field moisture capacity, available nitrogen and phosphorus, and contaminant concentrations were monitored. Biological land treatment proved to be a viable cost-effective option for the remediation of diesel fuel contaminated soils. The contaminated soils were shown to be quite amenable to microbial treatment if supplemented with nutrients and managed to maintain proper moisture and pH conditions. (See also W91-07662) (Mertz-PTT)
W91-07690

GROUNDWATER RECOVERY AND TREATMENT AS A SUPERFUND REMEDIAL ACTION: A CASE STUDY.
Environmental Protection Agency, Atlanta, GA. Region IV.
G. Powell, L. M. Smith, and M. Frank.
IN: Hazardous and Industrial Wastes: Proceedings of the 22nd Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 438-452. 4 fig, 5 tab, 4 ref.

Descriptors: *Cleanup operations, *Distler Brickyard Site, *Kentucky, *Site remediation, *Soil contamination, *Superfund, Aquifer management, Groundwater pollution, Groundwater quality, Hazardous wastes, Hydraulic conductivity, Industrial wastes, Injection wells, Volatile organic compounds.

The Distler Brickyard Site is located near the Ohio River, near West Point, Kentucky. Approximately 2350 waste drums were stored within a 3-acre area on the property from 1976 to 1979. A Superfund removal was initiated by EPA in 1982, in which the drummed wastes and highly contaminated soils were removed. Subsequent monitoring and subsurface investigations determined that groundwater and soil contamination consisting of various metals, volatile and semi-volatile organics had occurred onsite. Remedial actions were implemented onsite to reduce the existing contamination and prevent its migration offsite. The chosen remedial action proposed excavation, removal and offsite disposal of the contaminated soil; this occurred in 1988. Remedial plan for groundwater treatment included extracting the groundwater using a system of pumping wells, treatment of the contaminated water to the aquifer using injection wells, which provide additional hydraulic head to drive the contaminated groundwater towards the recovery wells. Contaminants in the fine grain aquifer appeared to be the source of contamination in the coarse grain aquifer, although the two were not believed to be hydrologicly connected. However, the fine grain aquifer had a very low hydraulic conductivity and movement of the contaminants into the coarse grain aquifer would take many years. Therefore, implementation of a coarse grain aquifer treatment system alone was not recommended. The pilot treatment system effectively reduced the contamination onsite and should prove capable for full scale treatment. Recommendations include sampling the coarse grain aquifer in order to monitor contaminant levels and then provide periodic treatment if levels rise above treatment standards. Further actions at the Distler Brickyard are pending until EPA reviews all recommendations and determines the most appropriate course of action. (See also W91-07662) (Mertz-PTT)
W91-07691

CASE HISTORY OF THE AMERICAN CREOSOTE WORKS SUPERFUND REMOVAL ACTION.
Weston (Roy F.), Inc., Memphis, TN.
D. Backus, and D. Jackson.
IN: Hazardous and Industrial Wastes: Proceedings of the 22nd Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 453-458. 2 ref.

Descriptors: *American Creosote Works Site, *Cleanup operations, *Phenolics, *Site remediation, *Superfund, *Tennessee, Clarification, Creosote, Filtration, Hazardous wastes, Hydrocarbons, Industrial wastes, On-site wastewater treatment, Phenols, Sludge treatment, Storage tanks, Wood preservatives.

American Creosote Works, Inc. operated as a wood preserving facility in Jackson, Tennessee from the early 1930's until 1981. The wood treating process utilized at the facility included the application of creosote and pentachlorophenol. Creosote is a complex mixture of hydrocarbons consisting of approximately 85-95% polynuclear aromatic hydrocarbons and 5-15% phenolics. Most the phenolics present are solids at ambient temperatures, with the exception of 2,3,4,6-tetrachlorophenol and pentachlorophenol which are both extremely soluble in water. The EPA contracted the Corps of Engineers to conduct a Remedial Investigation/Feasibility Study for the total site remediation during 1987. Operable Unit One dealt with the removal of creosote sludges, oils and contaminated water, as well as the demolition of plant process buildings and storage tanks. Removal actions began in 1989. 225,000 gallons of creosote sludge left in above ground storage tanks was dewatered and disposed of. The process selected for dewatering the creosote sludge was pressurized filtration. Supernatant effluent from the filter press was sent to a 50,000 gallon pool to await further treatment. The pool was used for clarification where the water-in-soil emulsion could begin to destabilize or separate. The next step in treatment was the precipitation of metals and other solids in solution. Filtration was then performed in a two-step process that resulted in a reduction of the total suspended solids. Next, activated carbon was used to adsorb any remaining solids. Between July 1989 and October 1989, 807,000 gallons of creosote slurry produced 10,100 cubic feet of creosote filter cake, 77,000 gallons of oil, and 271,200 gallons of contaminated water. Overall, the removal action was successful in the fact that all wastes that posed imminent threat to the environment or the public were removed from site and disposed of properly. (See also W91-07662) (Mertz-PTT)
W91-07692

EVALUATION OF THE EXTRACTION OF CHROMIUM FROM CONTAMINATED SOILS BY SOIL WASHING.
New Jersey Inst. of Tech., Newark. Dept. of Civil and Environmental Engineering.
H. N. Hsieh, D. Raghum, and J. Liskowitz.
IN: Hazardous and Industrial Wastes: Proceedings of the 22nd Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 459-469. 3 fig, 2 tab, 7 ref.

Descriptors: *Chromium, *Decontamination, *Site remediation, *Soil contamination, *Soil treatment, *Solvent extraction, Economic aspects, Hydrogen ion concentration, Particle size, Sludge treatment, Soil washing, Waste treatment.

Inorganic contaminants such as chromium and lead are not biodegradable. When cleaning up the contaminated sites, these inorganic contaminants can only be fixed in the soil or be flushed out. Soil washing promises to be both an effective and cost-efficient approach to cleaning up waste-contaminated sites. Soil washing extracts contaminants from a sludge-soil matrix using a liquid medium as the washing solution. During elutriation, sorbed contaminants are mobilized by solution formation of an emulsion, or by chemical reaction with the extracting solution. The washing solution is then treated for removal of the contaminants via a conventional wastewater treatment system. Field samples contaminated with chromium were collected from three different sites in Jersey City, New Jersey. At each site samples were obtained both from the surface and at a depth of three feet. The soil washing experiment was conducted using an upflow column. Results showed that 20-50% of the chromium in the samples was in the free form and could be removed by washing with water. It was

found that the optimum pH range for maximum removal of chromium was between 10-12. The washing process for different fractions of soil followed second order kinetics. The rate constants for various fractions did not vary significantly for the first part indicating that washing time was not dependent upon particle size for the solvent used. Removal efficiency was related to particle size, with -40 to +70 fraction giving the maximum, followed by -70 to +200. (See also W91-07662) (Mertz-PTT)
W91-07693

ENGINEERING EVALUATION FOR REMEDIATION OF AN UNLINED SLUDGE LAGOON.
Sadat Associates, Inc., Princeton, NJ.
B. Simpson, A. Hamidi, M. Sadat, J. Wiley, and L. Moore.
IN: Hazardous and Industrial Wastes: Proceedings of the 22nd Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 470-482. 3 fig, 5 ref.

Descriptors: *Cleanup operations, *Environmental engineering, *Site remediation, *Sludge drying, *Sludge lagoons, *Wastewater lagoons, Capillary suction, Cost analysis, Economic aspects, On-site investigations, Sand beds, Sand columns, Sludge disposal, Sludge treatment.

An engineering approach was taken to evaluate dewatering methods of sludge excavated from a ten acre unlined sludge lagoon. A number of constraints had to be considered while engineering the system such as regulatory limitations, site restrictions, constructability, and disposal costs. Field investigations were conducted to determine both the quality and quantity of sludge contained in the lagoon. Analytical results indicated that the material was non-hazardous. Approximately four million gallons of liquid were present at the surface of the lagoon. Also present was approximately 120,000 cubic yards of sludge material with solids content varying from less than 15% total solids to greater than 30% total solids. Treatability testing was performed in order to properly design a suitable dewatering system. The three tests conducted on the sludge were: capillary suction, bench scale sand columns, and a pilot scale sand bed exposed to natural conditions. From this study, drying cycle, application depth, chemical feed rate and final solids content were determined. An evaluation was conducted of available technologies based on their technical reliability, schedule implementability, and cost effectiveness. The information collected in the field and laboratory was significant for developing a conceptual dewatering system. The next phase of this project will consist of the preparation of final drawings and performance specifications so that a construction contractor can be selected to cleanup the site. This conceptual dewatering system will be presented to the regulatory agencies to expedite obtaining permits for construction of the sanitary landfill. This five-task investigative approach can be modified or used in total at other sites with similar environmental problems. The approach taken facilitated the review and screening of dewatering technologies. (See also W91-07662) (Mertz-PTT)
W91-07694

DURABILITY TESTING OF A STABILIZED PETROLEUM SLUDGE.
Bucknell Univ., Lewisburg, PA.
For primary bibliographic entry see Field 5E.
W91-07698

EVALUATION OF SILICON SLAG AS A LEACHATE FLOW MEDIUM.
Buchart-Horn, Inc., York, PA.
For primary bibliographic entry see Field 5E.
W91-07699

RECLAMATION PLANS AT URANIUM MILL TAILINGS SITES.
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
S. R. Abt, T. A. Shepherd, and J. D. Nelson.
IN: Hazardous and Industrial Wastes: Proceedings of the 22nd Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 570-579. 2 fig, 5 ref.

Descriptors: *Cleanup, *Land reclamation, *Site remediation, *Uranium mining, *Waste containment, *Waste stabilization, *eine wastes, Embankments, Nuclear Regulatory Commission, Regulations, Reservoir linings, Surface covers, Waste management.

Long-term stability of waste impoundments is of concern because of the long time periods over which various types of waste may remain active. Over the past decade much technology has been developed specifically for reclamation of uranium mill tailings impoundments. This technology may be applicable to reclamation of industrial waste impoundments in general. Title I and Title II sites which represent two different generations in uranium tailing impoundment construction are examined. The comparison between the two represent differences in philosophies as well as in impoundment type. Reclamation of uranium mill tailings impoundments in the US is controlled by Federal legislation, which has set forth the regulatory framework for reclamation plan approval. Title I requirements govern government-owned inactive sites and Title II requirements govern active tailings impoundments or those operated by private industries. Differences between Title I and Title II reclamation plans to achieve surface stability relate primarily to the embankment and surface covers. The differences in the cover designs result from engineering approaches or the regulatory process. Site-specific conditions that affect the selection of cover designs, and provides a comparative example to illustrate the effect of this condition are examined. Since the recent implementation of groundwater regulations based on EPA standards by the Nuclear Regulatory Commission, cover designs, as these designs impact achievement of the goals of the groundwater regulations, have come under scrutiny. (See also W91-07662) (Author's abstract)
W91-07700

EFFECT OF FREEZE/THAW CYCLES ON THE PERMEABILITY OF A FINE-GRAINED SOIL.
Rensselaer Polytechnic Inst., Troy, NY. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2G.
W91-07701

QUANTITATIVE STRUCTURE-ACTIVITY RELATIONSHIPS: NEW TOOLS FOR REMEDIATION OF CONTAMINATED GROUNDWATER.
Vanderbilt Univ., Nashville, TN. Dept. of Environmental and Water Resources Engineering.
D. H. Zitomer, and R. E. Speece.
IN: Hazardous and Industrial Wastes: Proceedings of the 22nd Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 626-644. 2 tab, 22 ref.

Descriptors: *Cleanup, *Decontamination, *Groundwater pollution, *Mathematical studies, *Molecular structure, *Remediation, *Structure-activity relationships, Algorithms, Biodegradation, Biological magnification, Chemical properties, Solubility, Toxicity, Water analysis.

Until recently, it was widely believed that the groundwater of the U.S. was essentially uncontaminated. Within the last decade, however, contamination has been found to be a significant problem. Unfortunately, any attempt to remediate contaminated aquifers is complicated by a lack of available data describing behavior of organic chemical contaminants and it is not economically possible to measure physicochemical parameters and toxicity of every new chemical. Therefore, new methods for the rapid and reliable estimation of physicochemical parameters of organic chemicals are needed when groundwater remediation strategies are being planned. One new technique that would presently solve some problems is Quantitative Structure Activity Relationships. These mathematical relationships predict chemical behavior--such as toxicity, bioconcentration, solubility and biodegradability--using molecular structure information gleaned from the chemical's structural formula. From the chemical structural formula, information about the total number of atoms, the kinds of atoms, and the linking pattern or bonding scheme of atoms in organic molecules is apparent. In addition, empirical algorithms have been devised to calculate structure encoding numbers such as the molecular connectivity indices. Six Quantitative Structure Activity Relationships which relate to groundwater remediation strategies can be used to predict aqueous solubility, Henry's constant, soil sorption, activated carbon sorption, five day biochemical oxygen demand, and toxicity of organic chemicals to aerobic heterotrophs. Each Quantitative Structure Activity Relationship offers an incisive view of the relationship between molecular structure and the behavior of organic chemicals in the environment. (See also W91-07662) (Author's abstract)
W91-07704

SELECTION OF AIR FLOW RATES AND CULTURES IN AEROBIC BIOTOWERS FOR REMOVAL OF HYDROCARBONS FROM WASTEWATERS.
Pittsburgh Univ., PA. Dept. of Civil Engineering.
S. Niaki, R. D. Neufeld, and J. E. Blair.
IN: Hazardous and Industrial Wastes: Proceedings of the 22nd Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 669-680. 5 fig, 2 ref.

Descriptors: *Aerobic treatment, *Air stripping, *Biological treatment, *Cleanup, *Flow rates, *Hydraulics, *On-site wastewater treatment, *Site remediation, *Wastewater treatment, *Water pollution treatment, Aromatic compounds, Benzene, Biodegradation, Gasoline, Hazardous wastes, Toluene.

A technique for the biodegradation of gasoline type aromatics at concentrations typical of starvation conditions was examined. An innovative technique was developed that may be suitable for the long-term remediation of fuel spills. For convenience in operation, organisms were installed in upflow submerged aerobic biotowers. Benzene, xylene, toluene, and ethylbenzene were used as gasoline surrogates for experimental work. The air stripping effects in the tower on toluene were measured at different air flow rates and the air stripping coefficient was determined. Additionally, innoculums from municipal activated sludge, final clarifier effluent, and six types of commercial culture preparations were evaluated using benzoic acid, a biodegradable aromatic. Preliminary results showed that an optimum air flow rate with minimal air stripping effects for volatile organic compounds can be used to provide pseudo-complete mix conditions within a biotower. In addition, using a shake test, culture activities can be screened for initial innoculation; however, commercial culture behavior was found to be inconsistent when examined under replicate experimental conditions. (See also W91-07662) (Mertz-PTT)
W91-07707

HOW CLEAN IS CLEAN. THE IMPORTANCE OF USING SITE-SPECIFIC FACTORS IN DEVELOPING CLEANUP LEVELS AT HAZARDOUS WASTE SITES.
Environmental Resources Management, Inc., Exton, PA.
B. N. Stephanotos.
IN: Hazardous and Industrial Wastes: Proceedings of the 22nd Mid-Atlantic Industrial Waste Conference. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 683-701. 3 fig, 2 tab, 5 ref.

Descriptors: *Cleanup, *Cleanup operations, *Hazardous wastes, *Model studies, *Risk assessment, *Site remediation, *Standards, Environmental effects, Environmental protection, On-site investigations, Path of pollutants, Water quality standards.

One of the principal objectives of remedial actions at hazardous waste sites is to ensure that residual concentrations of constituents present at the sites following such actions will not pose a threat to

human health and the environment. Target chemical concentrations in soils and groundwater were developed at several hazardous waste sites in the U.S. to guide the source control remedial designs to be undertaken at these sites. Establishing the basis for determining cleanup standards, or 'how clean is clean', prior to the commencement of the remedial design activities is necessary because waste and contaminated soil volumes dictate the remedial design and drive the costs of the remedy. Resolution of the how clean in clean question is achieved by designating a threshold level of contamination such that environmental media (soil or river sediments) containing hazardous residuals at that level or greater would be subjected to excavation, while media containing lower levels would be left undisturbed. A method has been developed for the derivation of cleanup criteria using environmental risk assessment techniques. This paper emphasizes the estimation of target release rates by means of environmental fate and transport modeling and the importance of using site-specific factors in developing cleanup levels at hazardous waste sites. The study shows that generic standards need to be modified prior to their application to specific sites because of the conservative assumptions that are incorporated into generic standards. The cleanup levels selected were the most stringent ones produced by the different exposure scenarios. The controlling exposure scenario for a particular compound depended on the physicochemical and toxicological properties of the compound. (See also W91-07662) (Author's abstract)
W91-07708

METHODOLOGY FOR DEVELOPING BEST DEMONSTRATED AVAILABLE TECHNOLOGY (BDAT) TREATMENT STANDARDS.
Environmental Protection Agency, Washington, DC. Office of Solid Waste.
R. April.
Available from the National Technical Information Service, Springfield, VA. 22161 as PB89-221428. Price codes: A05 in paper copy, A01 in microfiche. Report No. EPA/530-SW-89-048B, May 1989. 75p, 9 tab, append.

Descriptors: *Hazardous wastes, *Legislation, *Waste disposal, *Waste treatment, Hazardous and Solid Waste Amendment, Land disposal, Regulations, Toxic wastes.

The Hazardous and Solid Waste Amendments of 1984 (HSWA) imposed substantial new responsibilities on those who handle hazardous wastes, including stringent new restrictions on the land disposal of hazardous wastes and associated treatment residuals. This document summarizes EPA's approach for implementing the land disposal restrictions program. Before it can allow a waste to continue to be disposed of in or on the land, EPA must consider (RCRA section 3004 (d)(1)(A-C)): (1) the long-term uncertainties associated with land disposal; (2) the goal of managing hazardous waste in an appropriate manner in the first instance; and (3) the persistence, toxicity, mobility, and propensity to bioaccumulate such hazardous wastes and their hazardous constituents. Section 2 presents the legal authority under which the Agency is basing its regulations. Section 3 describes the technical methodology EPA uses to define treatment standards for restricted hazardous waste. Section 4 discusses variances from these treatment standards, and, finally, Section 5 presents the Agency's approach to the special problems raised by the 'acute hazardous' (P) and 'toxic' (U) listed hazardous waste categories in 40 CFR/261.33. (Lantz-PTT)
W91-07808

FINAL BEST DEMONSTRATED AVAILABLE TECHNOLOGY (BDAT) BACKGROUND DOCUMENT FOR WASTES FROM THE PRODUCTION OF 1,1,1-TRICHLOROETHANE: K028, K029, K095, AND K096.
Environmental Protection Agency, Washington, DC. Office of Solid Waste.
J. R. Berlow, and L. Jones.
Available from the National Technical Information Service, Springfield, VA. 22161 as PB89-221519. Price codes: A05 in paper copy, A01 in microfiche. Report No. EPA/530-SW-89-048N, May 25, 1989. 115p, 1 fig, 20 tab, 23 ref, 4 append.

Descriptors: *Best Demonstrated Available Technology, *Standards, *Trichloroethane, *Wastewater treatment, Chemical precipitation, Incineration, Land disposal, Organic compounds, Waste treatment.

In accordance with the amendments to the Resource Conservation and Recovery Act (RCRA) of 1976, enacted in the Hazardous and Solid Waste Amendments (HSWA) of November 8, 1984, the US EPA is establishing best demonstrated available technology (BDAT) treatment standards for the listed wastes identified in Title 40, CFR Section 261.32 as K028, K029, K095, and K096 from the production of 1,1,1-trichloroethane. This background document provides the Agency's rationale and technical support for selecting the constituents regulated in K028, K029, K095, and K096 nonwastewaters and K028 wastewaters and for developing treatment standards for these constituents. This document also provides waste characterization data that serve as a basis for determining whether a variance from treatment standards may be warranted for a particular type of K028, K029, K095, or K096 waste that is more difficult to treat than the wastes that were analyzed in developing the treatment standards for K028, K029, K095, and K096 nonwastewaters and K028 wastewaters. This background document presents the following waste-specific information: the numbers and locations of facilities that may be affected by the land disposal restrictions for K028, K029, K095, and K096; the processes generating these wastes; the waste characterization data; the technologies used to treat the wastes (or similar wastes, if any); and the treatment performance data on which the treatment standards are based, if appropriate. For K028, K029, K095, and K096 nonwastewaters, BDAT treatment standards for organic constituents are based on treatment performance data transferred from treatment of the ash residual from incineration of KK019. For K028 wastewaters, the BDAT treatment standards for organic constituents are based on treatment performance data transferred from the scrubber water residual from incineration of K019. BDAT treatment standards for metal constituents in K028 wastewaters are based on treatment performance data transferred from the effluent from lime and sulfide precipitation and vacuum filtration of a mixture of K062 and metal-bearing characteristic wastes. (Lantz-PTT)
W91-07809

WELL INSTALLATION AND DOCUMENTATION, AND GROUND-WATER SAMPLING PROTOCOLS FOR THE PILOT NATIONAL WATER-QUALITY ASSESSMENT PROGRAM.
Geological Survey, Reston, VA.
For primary bibliographic entry see Field 7A.
W91-07824

ECOLOGICAL PROBLEMS OF THE THERMICS OF HYDROELECTRIC STATIONS.
For primary bibliographic entry see Field 5C.
W91-07878

CSO ABATEMENT FOR BURLINGTON, VERMONT.
O'Brien and Gere Engineers, Inc., Syracuse, NY.
R. C. Ganley, and D. A. McCarthur.
Water Environment & Technology WAETEJ, Vol. 3, No. 2, p 36-43, February 1991. 2 fig, 6 tab.

Descriptors: *Combined sewer overflows, *Storm runoff, *Storm water management, *Urban runoff, *Vermont, *Wastewater treatment, Burlington, Design criteria, Lake Champlain, Project planning, Swirl vortex separator.

The city of Burlington, Vermont, which has a population of 40,000 and is situated on the shore of Lake Champlain, had a significant problem with combined sewer overflows (CSOs) causing discharge into Burlington Bay, with negative effects on local water quality. In 1987, a Final Facilities Plan for Municipal Wastewater Treatment was developed covering all work necessary to upgrade the Burlington collection and treatment system. After a workshop involving public works officials, consultants, Vermont regulatory personnel, and construction estimators, an evaluation of planned CSO management was recommended. This evaluation included determining CSO characteristics, comparing stormwater versus treatment options, forecasting solids removal from the CSO facilities site plan, and preparing recommendations for final facilities. The development of the design concept for CSO treatment concluded that the following major elements be included in the Burlington CSO treatment system: all CSO flows will pass through screening; all CSO flows up to the peak rate of the 10-year, 12-hour design storm will receive disinfection; and the best mix of storage and treatment recommends the construction of a swirl vortex separator with a peak capacity of 2.6 cu m/sec (mgd). Current estimates predict that the CSO facilities will be operational by summer 1992. (Rochester-PTT)
W91-07897

ACID EARTH: THE GLOBAL THREAT OF ACID POLLUTION.
For primary bibliographic entry see Field 5B.
W91-07903

WATER ACT 1989: CHAPTER 15.
For primary bibliographic entry see Field 6E.
W91-07904

WATER AND WASTEWATER EXAMINATION MANUAL.
Tennessee Technological Univ., Cookeville. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5A.
W91-07906

WORLD RESOURCES: 1990-91.
World Resources Inst., Washington, DC.
For primary bibliographic entry see Field 6G.
W91-07919

DATA ACQUISITION WITHIN A REGIONAL SCALE: THE EXPERIENCE OF THE REMOTE SATELLITE TRANSMISSION IN WEST AFRICA.
Institut Francais de Recherche Scientifique pour le Developpement en Cooperation, Abidjan (Ivory Coast). Centre ORSTOM d'Adiopodoume.
E. Servat, and J. M. Lapetite.
IN: Regionalization in Hydrology. IAHS Publication No. 191. International Association of Hydrological Sciences, Washington, DC. 1990. p 11-20, 3 fig, 8 ref.

Descriptors: *Data acquisition, *Hydrologic data collections, *Insect control, *Regional analysis, *Remote sensing, *Water quality management, *West Africa, Computer programs, Human diseases, Insecticides, River forecasting, Satellite technology, Stream discharge.

Onchocerciasis, or river blindness, is an endemic disease which causes great damage to the human population of West Africa. Within the World Health Organization (WHO) program to control this disease (OCP), it has been found that, by using remote satellite transmission, reliable data on the discharge of the water courses can be obtained. These data are necessary to calculate exactly how much insecticide should be introduced into the rivers. The satellite transmission of the data collected by automatic recorders offers the advantages of guaranteed access to data in all seasons, transmission of the water levels almost in real time, more reliable data than that from river gages, and quick and easy centralization of the data through the receiving equipment centers at the two aerial operation bases. Software for forecasting the discharge at different times was developed as a staff gage database manager, and has led to significant improvements in the OCP program: it avoids underdosage or overdosage of insecticide, and it increases the success rate and allows occasional suspension of treatment in some reaches. The OCP is

satisfied with the initial results and intends to complete its fleet of 100 remote transmission beacons as it extends the program towards the west. (See also W91-07920) (Fish-PTT)
W91-07922

BIG RIVER, CO LOUTH, IRELAND: A CASE STUDY IN RECOVERY.
Dundalk Regional Technical Coll. (Ireland). Dept. of Experimental Sciences.
D. J. Douglas, and J. McCreanor.
Annales de Limnologie ANLIB3, Vol. 26, No. 1, p 73-79, 1990, 2 fig, 3 tab, 10 ref.

Descriptors: *Industrial wastes, *Ireland, *River restoration, *Stream pollution, *Water pollution effects, *Water quality monitoring, Aquatic fungi, Biological oxygen demand, Case studies, Color, Macroinvertebrates, Recolonization.

As part of an ongoing program of water-quality monitoring, the chemical and biological effects of organic wastes discharged by the Cooley Alcohol Factory into the Big River, County Louth, Ireland, were monitored during the months of March and April from 1983 to 1988. Results showed conditions in the Big River to be very clean from the source to just above the factory outfall, but the river was grossly polluted downstream of the outfall and devoid of living organisms, with the exception of sewage fungus; the BOD of the effluent at the mouth of the discharge pipe was measured at 1440 mg/L. The effluent also had the effect of discoloring the river water (i.e., increasing the mean color from 10 to 500 Hazen units) and this discoloration extended some distance out to sea from the river's mouth. When the factory ceased production in June 1986, water quality improved immediately and within eight months significant signs of recolonization by macroinvertebrates were evident. Water color had fallen to 7.5 Hazen units and the BOD readings were characteristic of a clean river. Water quality continued to improve until the end of the survey in March 1988, by which time the river had returned to near-pristine conditions. (King-PTT)
W91-07984

EVALUATION OF WASTE WATER TOXICITY WITH THREE CYTOTOXICITY TESTS.
Munich Univ. (Germany, F.R.). Inst. fuer Zoologie and Hydrobiologie.
For primary bibliographic entry see Field 5A.
W91-07992

REGULATION OF THE TEMPERATURE REGIME OF LOWER POOLS OF HIGH-HEAD HYDRO DEVELOPMENTS.
For primary bibliographic entry see Field 8A.
W91-08035

SELENIUM BIOMETHYLATION IN AN ALKALINE, SALINE ENVIRONMENT.
California Univ., Riverside. Dept. of Soil and Environmental Sciences.
E. T. Thompson-Eagle, and W. T. Frankenberger.
Water Research WATRAG, Vol. 25, No. 2, p 231-240, February 1991. 3 fig, 6 tab, 47 ref.

Descriptors: *Biological wastewater treatment, *California, *Drainage water, *Evaporation ponds, *Methylation, *Selenium, *Water pollution treatment, Aerobic conditions, Bacteria, Bactericides, Culture media, Fungicides, Nitrates, Nitrites, Pesticides, Polymers, Proteins, Saline water, San Joaquin Valley, Sand, Sulfates.

Biomethylation of selenium in evaporation pond water was studied and optimized in laboratory-incubated mesocosms. Methylating microorganisms were present in all pond waters collected from the San Joaquin Valley, California, and were inhibited by bactericides but not by fungicides. The addition of casein increased bacterial numbers 1,000-fold and stimulated biomethylation 25-fold. The provision of growth matrices (sand, glass beads, or nylon polymers) stimulated Se biomethylation in unamended water but not in peptone-amended water. Biomethylation was optimal in a well-mixed, aerobic system amended with a protein source. Cofactors enhanced the production of dimethylselenide in peptone-amended pond water. The species of inorganic Se present, SeO3(2-) and SeO4(2-), had little effect on the methylation efficiency. Increasing the Se concentration from 1.9 to 101.9 mg Se/L in peptone-amended pond water decreased the percentage of Se removed from 8 to 0.1%. Selenium removal ranged between 8% and 100% for peptone-amended pond waters containing between 2.2 and 0.02 micrograms Se/L, respectively. Biomethylation was inhibited by 0.1 M nitrate and nitrite, but additional sulfate (0.1, 1 M) had no effect on dimethylselenide release. It may be possible to apply these findings in the design of a bioreactor to deselenify agricultural drainage water. (Author's abstract)
W91-08059

POLICY, LAW AND IMPLEMENTATION OF INDUSTRIAL WASTEWATER POLLUTION CONTROL.
Central Pollution Control Board, New Delhi (India).
P. C. Tyagi.
Water Science and Technology WSTED4, Vol. 24, No. 1, p 5-13, 1991. 3 tab.

Descriptors: *Environmental policy, *India, *Industrial wastes, *Wastewater pollution, *Water pollution control, Administrative agencies, Developing countries, Institutional constraints, Law enforcement, Legal aspects, Legislation, Monitoring, Regulations, Rivers, Taxes, Technology, Water consumption, Water quality standards, Water use.

The policy of industrial wastewater pollution control in India is based on the 'polluter pays' principle. All industrial units are held strictly liable for abatement of pollution caused by them. Prevention is emphasized. The index for health and environmental considerations is summed up in the water quality criteria for the specified 'designated best use,' which is the use requiring the best quality of water among the various uses made by the people of a given stretch of a river. Additional topics discussed include legislation, water consumption taxes levied on specific industries, the organizational structure of regulatory boards, pollution control strategies, pollution assessment, enforcement, the environmental clearance of proposed industrial sites, the special problem of clusters of small-scale industrial units, and financial incentives for pollution control. Pollution caused by industrial wastewater in India is increasing at an alarming rate. Suggested goals include improving wastewater treatment technologies, reducing industrial water consumption, strengthening and reorganizing pollution control institutions, and mounting a massive program for environmental awareness and training. (Doria-PTT)
W91-08060

IMPROVED INDUSTRIAL WATER POLLUTION CONTROL IN BOTSWANA: FROM STRATEGY TO PRACTICAL IMPLEMENTATION.
Botswana Dept. of Water Affairs, Gaborone.
T. Makela.
Water Science and Technology WSTED4, Vol. 24, No. 1, p 15-24, 1991. 1 tab, 9 ref.

Descriptors: *Botswana, *Developing countries, *Environmental management, *Institutional constraints, *Water pollution control, Administrative agencies, Automation, Data processing, Inspection, Institutions, Law enforcement, Legal aspects, Legislation, Monitoring, Permits.

A new strategy for water pollution control has been developed in Botswana, based on a practical approach with parallel activities in several areas so that delays in some areas will not hamper achievements in others. These areas of development include: policy formulation, legislation, practical principles for handling pollution cases, inspection and monitoring, systematic guidelines, filing and reporting systems, and cooperation with polluters and among different authorities. The following principles are suggested by the Botswana experience: (1) emphasize programs rather than projects since better development is achieved with gradual and flexible approaches in several areas of practical work; (2) establish sound policies with the prime responsibility on polluters; the lack of clearly defined and detailed policies leads to random priorities, vague responsibilities, and a fire-fighting approach to problems; and (3) formulate policies based on trends and actual hazards. (Doria-PTT)
W91-08061

INTEGRATED WATER RESOURCES PLANNING AS A FACTOR IN ENVIRONMENTAL POLLUTION CONTROL.
Nairobi Univ. (Kenya). Dept. of Civil Engineering.
G. G. Ngirane-Katashaya.
Water Science and Technology WSTED4, Vol. 24, No. 1, p 25-34, 1991. 2 fig, 17 ref.

Descriptors: *Regional planning, *Water conservation, *Water pollution control, *Water resources management, *Water use, Case studies, Cost analysis, Economic aspects, Environmental impact statement, Environmental protection, Hydroelectric plants, Irrigation effects, Planning, River basin development, Social aspects.

Integrated water resources planning (IWRP) seeks to rationalize water resources projects in a region for optimum utilization of water, appropriate conservation, cost-effectiveness, and attainment of maximum economic and socio-environmental benefits. Those aspects of water resources planning that interact with the environment are reviewed, and corresponding environmental conservation parameters and various approaches to pollution control are presented. Mutually pertinent points identify the planning parameters. Topics discussed include conventional environmental pollution control measures, pollution mitigation through regional planning, pollution mitigation through phased implementation, pollution mitigation through multipurpose projects, and pollution control through multi-objective and multidisciplinary planning. Case studies of IWRP (the Tana and Athi Rivers Development Authority (TARDA) and the Kiambere hydroelectric project) illustrate the following recommendations: (1) multidisciplinary interaction is needed at the inception of a project; (2) continuous monitoring of environmental pollution is needed; and (3) public awareness needs to be improved. (Doria-PTT)
W91-08062

SURFACE WATER QUALITY MONITORING AND POLLUTION CONTROL IN GHANA.
Water Resources Research Inst., Accra (Ghana).
For primary bibliographic entry see Field 7A.
W91-08063

PB(II) REMOVAL FROM KAOLINITE BY ELECTROKINETICS.
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
J. Hamed, Y. B. Acar, and R. J. Gale.
Journal of Geotechnical Engineering (ASCE) JGENDZ, Vol. 117, No. 2, p 241-271, February 1990. 14 fig, 6 tab, 39 ref.

Descriptors: *Clay minerals, *Decontamination, *Electro-osmosis, *Heavy metals, *Lead, *Soil contamination, Absorption, Adsorption, Cation exchange, Conductivity, Electrochemistry, Electrodes, Energy, Groundwater protection, Hydrogen ion concentration, Ions, Kaolinite, Moisture content, Osmosis, Saturation.

The potential of electro-osmosis for the removal or separation of contaminants in soil requires a better understanding of the electrochemistry associated with electrokinetic phenomena and its relation to the mechanical behavior. Electro-osmosis tests were conducted on saturated kaolinite specimens loaded with Pb(II) to investigate the efficiency and energy requirements of the process in removing this heavy metal. Kaolinite specimens were loaded with 118 to 145 micrograms of Pb(II) per gram of dry soil, below the cation exchange capacity of the mineral. The flow in electro-osmosis with open electrodes is time-dependent and is strongly influ-

enced by electrochemistry resulting from pH gradients. The absorbed Pb(II) was removed 75% to 95% by the process. The extent of removal is directly related to the pH gradients developed in the process. The total charge passed to remove Pb(II) varied between 1,400 and 2,000 amp-hr per cubic meter of soil. The energy requirement for the removal of Pb(II) in these tests was less than 29 to 60 kWh per cubic meter of soil processed. (Author's abstract)
W91-08080

OVERVIEW OF WATER FOR ENVIRONMENTAL MANAGEMENT.
Foundation for Research Development, Pretoria (South Africa).
For primary bibliographic entry see Field 6D.
W91-08094

KINETICS OF BACTERIAL DEGRADATION OF BENZYLAMINE IN A MONTMORILLONITE SUSPENSION.
Cornell Univ., Ithaca, NY. Inst. for Comparative and Environmental Toxicology.
For primary bibliographic entry see Field 5B.
W91-08098

WASTEWATER TREATMENT MODEL FOR WASTE HEAT UTILIZATION ASSESSMENT.
For primary bibliographic entry see Field 5D.
W91-08111

OXYGEN CONDITIONS IN THE DEEP WATER OF KIEL BAY AND THE IMPACT OF INFLOWING SALT-RICH WATER FROM THE KATTEGAT.
Kiel Univ. (Germany, F.R.). Inst. fuer Meereskunde.
For primary bibliographic entry see Field 2L.
W91-08180

EFFECTIVENESS OF THE ADDITION OF ALKALINE MATERIALS AT SURFACE COAL MINES IN PREVENTING OR ABATING ACID MINE DRAINAGE: PART 1. GEOCHEMICAL CONSIDERATIONS.
Geological Survey, Harrisburg, PA.
C. A. Cravotta, K. B. C. Brady, M. W. Smith, and R. L. Beam.
IN: Proceedings of the 1990 Mining and Reclamation Conference and Exhibition, April 23-26, 1990, Charleston, West Virginia. 1990. p 221-225, 27 ref.

Descriptors: *Acid mine drainage, *Alkalinity, *Coal mines, *Environmental chemistry, *Geochemistry, *Pennsylvania, *Water pollution prevention, *Water pollution treatment, Calcium carbonate, Calcium hydroxide, Calcium oxide, Chemical reactions, Coal mining effects, Hydrogen ion concentration, Mine wastes, Sulfur.

The addition of alkaline materials to supplement deficient 'neutralization potential' (NP) of mine spoil, and thus to prevent or abate acid mine drainage, has not been successful at most surface coal mines in Pennsylvania. A basic problem may have been an improper accounting of the acid production potential and, inadequate addition rates of CaCO3, CaO, or Ca(OH)2 at many mines. The commonly used acid/base accounting method is based on the following overall reaction: FeS2 + CaCO3 + 3.75 O2 + 1.5 H2O = Fe(OH)3 + SO4 + 2Ca + 2CO2 (g), where the acidity from 1 mole of pyrite (FeS2) is neutralized by 2 moles of CaCO3. This method presumes that gaseous CO2 will exsolve, and therefore may underestimate by up to a factor of 2 the quantity of CaCO3 required to neutralize the maximum potential acidity (MPA) in the mine spoil. A review is presented of some geochemical reactions involving FeS2, and various alkaline additives that support the argument that the acid/base accounting method for computing MPA from overburden analyses should be revised. Considering the stoichiometry of the following reaction: FeS2 + 4CaCO3 + 3.75 O2 + 3.5 H2) = Fe(OH)3 + 2SO4 + 4Ca + 4 HCO3, 4 moles of CaCO3 are required to neutralize the maximum potential acidity produced by the oxidation of 1 mole of FeS2. Therefore the multiplication factor for computing MPA from overburden sulfur concentration, in weight percent, should be increased from 31.25 to 62.5. (See also W91-08190) (Author's abstract)
W91-08189

EFFECTIVENESS OF THE ADDITION OF ALKALINE MATERIALS AT SURFACE COAL MINES IN PREVENTING OR ABATING ACID MINE DRAINAGE: PART 2. MINE SITE CASE STUDIES.
Pennsylvania Dept. of Environmental Resources, Harrisburg.
K. B. C. Brady, M. W. Smith, R. L. Beam, and C. A. Cravotta.
IN: Proceedings of the 1990 Mining and Reclamation Conference and Exhibition, April 23-26, 1990, Charleston, West Virginia. 1990. p 227-241, 11 fig, 2 tab, 22 ref.

Descriptors: *Acid mine drainage, *Alkalinity, *Case studies, *Coal mines, *Environmental chemistry, *Geochemistry, *Water pollution prevention, Chemical reactions, Mine wastes, Pennsylvania, Sulfur.

The effectiveness of preventing or ameliorating acid mine drainage (AMD) through the application of alkaline additives is evaluated for 8 surface coal mines in Pennsylvania. Many of the mine sites had overburden characteristics that made prediction of post-mining water quality uncertain. Alkaline materials were applied at rates ranging from 42 to > 1000 tons as CaCO3/acre. In addition, two sites that were mined and reclaimed without alkaline additives are included for competitive purposes. Overburden sulfur concentration and 'neutralization potential' (NP) data for multiple strata at each mine site were used to compute the cumulative, mass weighted 'maximum potential acidity' (MPA) and 'net neutralization potential' (NNP = NP-MPA) by using three different calculation methods. Post reclamation water quality data were used to compute the net alkalinity. The most conservative determination of NNP, whereby MPA is calculated by multiplying the total sulfur concentration, in weight percent, by 62.5 instead of 31.25, yielded the best agreement with net alkalinity (matching signs on NNP and net alkalinity). The error in prediction using each method was that the reclaimed overburden was computed to be alkaline overall (NNP > 0), but the post-reclamation water was acid (net alkalinity < 0). In general, alkaline addition rates were probably insufficient to neutralize or too late to prevent, acid production in the mine spoil. At six of the seven mine sites that had overburden with insufficient NP relative to MPA (NNP < 0), the addition of alkaline materials failed to create alkaline mine drainage; AMD was formed or persisted. A control site generated severe AMD. Two sites that had substantial, natural alkaline overburden produced alkaline drainage. Although the addition rates appear to be inadequate, other factors such as unequal distribution and exposure of the acid forming or neutralizing materials and geohydrological variability, complicate the evaluation of relative effectiveness of using different alkaline materials and placement of the acid or alkaline producing materials. (See also W91-08189) (Author's abstract)
W91-08190

TOXICITY REDUCTION IN INDUSTRIAL EFFLUENTS.
Van Nostrand Reinhold, New York. 1990. 350p. Edited by Perry W. Lankford and W. Wesley Eckenfelder.

Descriptors: *Industrial wastewater, *Toxicity, *Wastewater treatment, *Water pollution effects, *Water quality control, Bioassay, Biological wastewater treatment, Laboratory methods, Sludge, Volatile organic compounds.

The toxicity of manufacturing wastewaters to fish and other aquatic organisms is now being used by state and federal regulators to monitor and restrict industrial wastewater discharges. As a result, there is a great need for guidance on the subject of aquatic toxicity reduction in the field of industrial water pollution control. This book is a comprehensive reference source on the testing protocols, comparative data, and treatment techniques for effective toxicity reduction. Included in this book are detailed chapters covering various methods for toxicity reduction, such as the removal of metals, aerobic biological treatment, stripping of volatile organics, and management of sludges from toxic wastewater treatment. The book features: a complete overview of the subject, including background material for newcomers to the field; a basic summary and comparison of alternate treatment procedures; the latest methods for the identification of toxic components that readers can use for testing in their own laboratories; a description of applicable technologies for toxicity reduction; actual data from the use of processes that allow readers to compare technologies; solids management requirements including handling and disposal; useful economic comparisons of technologies; and illustrative case studies that demonstrate the application of the latest toxicity reduction technology and data to specific situations. (See also W91-08192 thru W91-08204) (Lantz-PTT)
W91-08192

SOURCE IDENTIFICATION, TESTING, AND TREATMENT.
Eckenfelder, Inc., Nashville, TN.
For primary bibliographic entry see Field 5B.
W91-08195

REMOVAL OF METALS TO NONTOXIC LEVELS.
Eckenfelder, Inc., Nashville, TN.
For primary bibliographic entry see Field 5D.
W91-08196

ECONOMICS OF TOXICITY REDUCTION.
Eckenfelder, Inc., Nashville, TN.
For primary bibliographic entry see Field 6C.
W91-08204

6. WATER RESOURCES PLANNING

6A. Techniques Of Planning

FLOW AND CONTAMINANT SIMULATIONS FOR A COMPLEX GROUNDWATER SYSTEM FOR THE PURPOSE OF RISK ASSESSMENT.
NUS Corp., Pittsburgh, PA.
For primary bibliographic entry see Field 5B.
W91-07175

RISK COMMUNICATION STRATEGIES: FOUR HAZARDOUS WASTE SCENARIOS.
ENSCO Environmental Services, Inc., Fremont, CA.
For primary bibliographic entry see Field 5G.
W91-07176

WATER RESOURCES DEVELOPMENT IN ASIA AND THE PACIFIC: DAM SAFETY EVALUATION AND MONITORING, WATER TARIFFS AND RAIN-WATER HARVESTING.
Economic and Social Commission for Asia and the Pacific (UN), Bangkok (Thailand).
Water Resources Series No. 63, 1989. United Nations Economic and Social Commission for Asia and the Pacific, Bangkok, Thailand. 118p, 13 fig, 42 tab.

Descriptors: *Asia, *Dam stability, *Tariff, *Water harvesting, *Water resources development, Australia, Dams, Hydraulic structures, Japan, Monitoring, New Zealand, Pakistan, Rain, Safety, Sri Lanka, Thailand, Water resources.

In the Economic and Social Commission for Asia and the Pacific (ESCAP) region, many countries have built a large number of dams for hydroelectric power generation and/or impounding flood waters to regulate low flow in the dry season for

irrigation and domestic and industrial water supplies. According to the latest available information, in 1982 there were 23,120 existing dams 15 m or more in height in 14 selected countries in the ESCAP region. Rockfill, concrete arch and other types of dams accounted for 8%. Of the total, 93% were completed after 1950. In March 1987, the secretariat circulated a questionnaire on dam safety to the national committees on large dams of 14 member countries of the ESCAP region, seeking confirmation of the statistical data on existing dams, and information on the operation and maintenance practices of monitoring and evaluation of dam safety and the general practices of determining design criteria or standards of dams. Replies from five countries (Australia, Japan, New Zealand, Sri Lanka and Thailand) were achieved. The reply from Sri Lanka indicated that the measuring and monitoring systems of the existing dams 15-59 m in height were largely inadequate and there had never been a safety evaluation of existing dams. In the three developed countries, Australia, Japan and New Zealand, various guidelines for dam instrumentation and monitoring systems, design floods, design criteria and geological investigation of dam foundations had been published. Whereas dams have provided mankind with essential benefits such as water supply, irrigation, hydropower, flood control and recreation, they have also posed increased hazards. Dam failures in recent years have drawn the attention of Governments throughout the world to the necessity for devising means of monitoring dams for safety with the objective of identifying, reducing and eliminating deficiencies in time. Chemical changes, aging and deterioration of the materials can set in. A complete discussion on all the adverse conditions that could develop is not considered necessary in this report because enough literature on the subject is readily available. It is, however, intended to stress the need for a systematic and continuing process of monitoring and evaluation of dam safety by qualified and specialized personnel to eliminate the risks of failure. (Lantz-PTT)
W91-07192

LAND AND WATER RESOURCE MANAGEMENT IN ASIA.
International Bank for Reconstruction and Development, Washington, DC. Economic Development Inst.
For primary bibliographic entry see Field 6B.
W91-07194

MANAGED AQUATIC ECOSYSTEMS.
Ecosystems of the World, 29. Elsevier Science Publishing Co., New York. 1987. 166p. Edited by R. George Michael.

Descriptors: *Aquatic environment, *Ecosystems, *Europe, *Fish management, *India, *Japan, *Reviews, *Water management, *Water resources management, Algae, Carp culture, Habitats, Oyster culture, Reservoir operation.

Several aquatic management practices representing different geographical areas and cultural backgrounds are reviewed. These range from the age-old carp culture and management in Europe and other continents to the more recent intensive management and mass culture of autotrophic microalgae. In addition, oyster culture in coastal Japan, and the management of man-made reservoirs in India are described. An ecosystem approach is emphasized. Data on the structural and functional aspects of each of the habitats are provided and the interrelationships between various factors in the context of the species cultured are presented, a departure from more conventional, production-oriented treatment of the topics. (See W91-07418 thru W91-07423) (Medina-PTT)
W91-07417

DROUGHT MANAGEMENT AND ITS IMPACT ON PUBLIC WATER SYSTEMS.
For primary bibliographic entry see Field 3D.
W91-07794

WHAT ARE ACCEPTABLE RISKS FOR PUBLIC SYSTEMS.
Los Angeles City Dept. of Water and Power, CA.
For primary bibliographic entry see Field 3D.
W91-07797

DROUGHT MANAGEMENT OPTIONS.
Southern Illinois Univ., Carbondale. Dept. of Geography.
For primary bibliographic entry see Field 3D.
W91-07798

TOWARDS SITUATION-SPECIFIC MANAGEMENT IN IRRIGATION.
International Inst. for Land Reclamation and Improvement, Wageningen (Netherlands).
For primary bibliographic entry see Field 3F.
W91-07912

INTEGRATED WATER RESOURCES PLANNING AS A FACTOR IN ENVIRONMENTAL POLLUTION CONTROL.
Nairobi Univ. (Kenya). Dept. of Civil Engineering.
For primary bibliographic entry see Field 5G.
W91-08062

COST-EFFECTIVENESS OF THE STREAMFLOW-GAGING PROGRAM IN MINNESOTA.
Geological Survey, St. Paul, MN. Water Resources Div.
For primary bibliographic entry see Field 7B.
W91-08185

6B. Evaluation Process

ECONOMICS OF AN EFFECTIVE UNDERGROUND STORAGE TANK (UST) MANAGEMENT PROGRAM.
For primary bibliographic entry see Field 5G.
W91-07178

LAND AND WATER RESOURCE MANAGEMENT IN ASIA.
International Bank for Reconstruction and Development, Washington, DC. Economic Development Inst.
P. Sun, J. Dixon, C. Jesena, and T. Aoki.
Economic Development Institute Seminar Report No. 20, 1989. 54p, 3 append.

Descriptors: *Asia, *Education, *Land management, *Water resources management, Case studies, Climatology, Economic aspects, Information systems, Land use, Workshops.

In November 1986, the Economic Development Institute, Agriculture and Rural Development Division (EDIAR) organized a two-week seminar in Washington, DC, on Land and Water Resources Management. This was the first of a series of seminars in which the assessment and management of ecosystems was conducted, and it drew participants from 11 countries in Africa, Asia, and Latin America. This report relates to the third seminar of the series, for ASian participants, that took place in March 1988 at the headquarters of Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA) at Los Banos, Philippines. The report opens with an overview of the seminar discussions. Chapter 1 then sets out the objectives, scope, and themes of the seminar--leading issues in land and water resource management in Asia; land, water, and climate information systems; farming and other land use systems (including agroforestry); economic analysis, incentives, and the policy environment; voluntary and involuntary land settlement; country case studies; and country options. This is followed, in chapters 2-5, by summaries of the papers presented and the related discussions on the main subject areas. Chapters 6 and 7 deal with specific experiences with voluntary and involuntary land settlements and country experiences (in Japan, Nepal, Philippines, and Thailand). The final two chapters summarize group discussions and set out the main themes for the consideration of country options. (Lantz-PTT)
W91-07194

EVALUATING THE COSTS OF PACKED-TOWER AERATION AND GAC FOR CONTROLLING SELECTED ORGANICS.
Environmental Protection Agency, Cincinnati, OH. Drinking Water Research Div.
For primary bibliographic entry see Field 5D.
W91-07605

CHANGING EMPHASIS OF THE U.S. GEOLOGICAL SURVEY ACTIVITIES IN GROUNDWATER HYDROLOGY IN THE 1980'S.
Geological Survey, Reston, VA.
J. S. Rosenshein, and R. L. Laney.
IN: Recent Advances in Ground-Water Hydrology. American Institute of Hydrology. (1989). p 533-545, 5 fig, 21 ref.

Descriptors: *Aquifer systems, *Groundwater resources, *Regional Aquifer System Analysis (RASA), *Research priorities, *Water resources, Economic aspects, Geochemistry, Groundwater movement, Groundwater pollution, Groundwater quality, Legislation.

The past decade has seen a major change in US Geological Survey (USGS) activities in groundwater hydrology. Prior to the late 1970's, the emphasis of most groundwater studies was on water availability at the state and local level. In 1977, Congress, in response to the drought of the mid-1970's, appropriate funds for Regional Aquifer Systems Analysis studies by the USGS. Twenty-eight major multi-state aquifers were identified for analysis of their geohydrologic framework, flow system, and water quality. In the late 1970's and early 1980's, Federal legislation and headline catching news reports about groundwater contamination created a National awareness and concern for these problems. As a result, the number of USGS studies addressing groundwater contamination increased during the 1980's under the Survey's Federal, Other Federal Agencies, and Federal-State Cooperative Programs. Specific Federal activities related to groundwater contamination include: National Water-Quality Assessments pilot groundwater studies, Toxic-Substances Hydrology studies, and studies of the hydrology of the Nevada Nuclear Waste Site, and hazardous substances contamination on military installations. Currently (1988), a significant part of the USGS's Federal-State Cooperative Program includes studies of water quality and contamination. Basic and applied research by the Survey has advanced the understanding and capability of the scientific community for studying groundwater quality issues. Advances in simulation and in equilibrium geochemistry by the USGS, for example, are applied routinely by hydrologists nationwide. The emphasis of USGS research and technical activities relative to groundwater quality will continue to grow in an effort to assist the Nation address modern-day concerns about groundwater contamination. (Author's abstract)
W91-07814

6C. Cost Allocation, Cost Sharing, Pricing/Repayment

PROBABILISTIC COST EFFECTIVENESS IN AGRICULTURAL NONPOINT POLLUTION CONTROL.
Pennsylvania State Univ., University Park. Dept. of Agricultural Economics and Rural Sociology.
For primary bibliographic entry see Field 5G.
W91-07362

ECONOMIC ANALYSIS OF WASTEWATER SYSTEM RETROFITS FOR THE METAL SURFACE FINISHER.
JACA Corp., Fort Washington, PA.
For primary bibliographic entry see Field 5D.
W91-07672

IRRIGATION PUMPING COSTS.
For primary bibliographic entry see Field 3F.
W91-07806

IRRIGATION TECHNOLOGY AND COMMERCIALIZATION OF RICE IN THE GAMBIA: EFFECTS ON INCOME AND NUTRITION.
International Food Policy Research Inst., Washington, DC.
For primary bibliographic entry see Field 3F.
W91-07908

ECONOMICS OF TOXICITY REDUCTION.
Eckenfelder, Inc., Nashville, TN.
K. D. Torrens.
IN: Toxicity Reduction in Industrial Effluents. Van Nostrand Reinhold, New York. 1990. p 316-336, 10 tab, 15 ref.

Descriptors: *Cost analysis, *Cost-benefit analysis, *Economic aspects, *Wastewater treatment, *Water pollution control, Activated carbon, Adsorption, Air stripping, Biological wastewater treatment, Chemical precipitation, Chemical treatment, Costs, Effluents, Oxidation, Sludge treatment.

Economics play a critical and often decisive role in final process selection. In many cases, there are several different treatment technologies which can achieve the required effluent quality, but there will typically be significant differences in capital and operating costs. Rational determination of these cost differences, followed by development of accurate final cost estimates, is critical to successful project completion. In general, development of cost estimates requires a knowledge of the following items: wastewater characterization data; design parameters for applicable treatment processes; effluent requirements; and, unit cost information of treatment processes under consideration. Final process costs should be compared on a present value (PV) basis to account for the effects of capital and operating costs over the life of the plant. This method of comparison provides a rational basis for process selection from estimates of long-term system costs. Present value analysis converts all costs for the life of the system to today's value based upon a discount rate selected to correspond with the owners estimated cost of funds. Constant operation and maintenance costs can be converted back to present value by multiplying the cost time a PV factor for the appropriate discount rate and project economic life. The same can be done with anticipated replacement costs or major one time costs. Following this conversion, these PV costs can be summed and added to the initial capital cost to determine total PV. The PV of each alternative can then be compared and a selection made. The remainder of this chapter discusses various economic features which should be considered when choosing between the following wastewater treatment technologies: biological treatment--aerobic and anaerobic processes; carbon adsorption--PACT and GAC; chemical oxidation--H2O2 and O3; precipitation; stripping; and sludge handling methods. (See also W91-08191) (Lantz-PTT)
W91-08204

6D. Water Demand

GROUND-WATER CONDITIONS IN UTAH, SPRING OF 1990.
Geological Survey, Salt Lake City, UT. Water Resources Div.
L. R. Herbert.
Cooperative Investigations Report No. 30, 1990. 84p, 44 fig, 3 tab, 4 ref.

Descriptors: *Groundwater resources, *Utah, *Water use, Groundwater budget, Groundwater irrigation, Groundwater mining, Groundwater recharge, Industrial water, Precipitation, Surface-groundwater relations, Wells.

The estimated total withdrawal of water from wells in Utah during 1989 was about 851,000 acre-ft, which is about 30,000 acre-ft more than the estimate for 1988 and about 107,000 acre-ft more than the average annual withdrawal for 1979-88. The increase in withdrawal was predominantly for irrigation, which was about 504,000 acre-ft in 1989, an increase of 62,000 acre-ft from 1988. Withdrawal for public supply was about 230,000 acre-ft, which is 1,000 acre-ft less than the estimate for 1988. Withdrawal for industrial use was about 52,000 acre-ft, which is about 27,000 acre-ft less than the 1988 estimate. Of the 16 areas of major groundwater development referred to in this report, only five areas, Curlew Valley, Cache Valley, the East Shore area, Salt Lake Valley, and the Beryl-Enterprise area, had decreases in groundwater withdrawals in 1989. Withdrawals in 12 of the 16 areas exceeded the 1979-88 annual average for each area. The quantity of water withdrawn from wells is related too demand and availability of water from other sources, which in turn are partly related to local climatic conditions. Calendar year 1988 was the first year of generally less-than-average precipitation in Utah after six years of greater-than-average precipitation. This trend of less-than-average precipitation continued in 1989. Of the 33 weather stations throughout Utah for which average annual precipitation values and graphs of cumulative departure from average annual precipitation are included in this report, 32 stations recorded precipitation in 1989 that was less than the average annual value. The largest negative departure from average precipitation was 8.15 inches, recorded at Ogden Pioneer Power House near Ogden. Only one of the 33 weather stations, Callao, recorded greater-than-average precipitation in 1989, with a positive departure of 0.08 inches. (Lantz-PTT)
W91-07246

WATER USE IN GEORGIA BY COUNTY FOR 1987.
Georgia Dept. of Natural Resources, Atlanta.
V. P. Trent, J. L. Fanning, and G. A. Doonan.
Information Circular 85, 1990. 112p, 5 fig, 4 tab, 17 ref, append.

Descriptors: *Data collections, *Georgia, *Water use, Competing use, Databases, Domestic water, Georgia Water-Use Data System, Industrial water, Information exchange, Irrigation water, Municipal water, Water demand.

Georgia's rapidly increasing population (13.9% since 1980), the increased demand for water for irrigation and industry, and 2 years of well below-normal precipitation across much of the State have caused concern about increased stress on the State's water supply. The ability to balance Georgia's growing need for water depends on knowing as much as possible about the State's water supply and water use. The Georgia Water-Use Program is a cooperative project between the Georgia Geologic Survey and the US Geological Survey. The purpose of the project is to collect, compile, and disseminate information on the principal water users in the State. By storing all water use information in a centralized database, the Georgia Water-Use Data System (GWUDS), the Georgia Water-Use Program provides the information necessary for water managers, hydrologists, and other scientists to manage and protect the State's water resources. This report provides water use estimates for Georgia by category for 1987, and includes data for each county by water use category. Water use data are obtained from the Georgia Environmental Protection Division (EPD) and from various Federal, State, and local sources, and are stored in the GWUDS database. Cities, industries, and other nonagricultural water users who withdraw more than 100,000 gal/day (gpd) are required to obtain withdrawal permits from EPD, and to report withdrawals monthly. Most of the data included are withdrawals reported by permitted users. Nonpermitted water use is estimated by using various data sources and estimation methods. Irrigation water use estimates are calculated from data obtained from the Cooperative Extension Service (CES) biannual Irrigation Survey. Water use estimates for the domestic and livestock categories are calculated by using census populations and a per capita water use estimate. Instream water use by hydroelectric powerplants is obtained from plant owners. (Lantz-PTT)
W91-07823

WATER-USE INFORMATION FOR THE MISSOURI RIVER BASIN.
Geological Survey, Rolla, MO. Water Resources Div.
L. A. Waite.
Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Open File Report 90-189, (1990). 6p, 1 ref.

Descriptors: *Data storage and retrieval, *Information systems, *Missouri River Basin, *Water use, Agriculture, Competing use, Data collections, Domestic water, Industrial water, Irrigation, State jurisdiction, Statistical analysis, Wastewater treatment, Water supply.

Statistics on agricultural, domestic, and industrial water use are required for the planning, management, and development of the Nation's and the Missouri River basin's water resources. The Survey, in cooperation with other Federal, State, and local agencies, has developed a computerized data system called the State Water-Use Data System (SWUDS). SWUDS currently is organized into 12 water use categories: Agriculture, non-irrigation (AG); Commercial (CO); Domestic (DO); Industrial (IN); Irrigation (IR); Mining (MI); Power generation--Fossil fuel (PF), Geothermal (PG), Hydroelectric (PH), Nuclear (PN); Sewage treatment (ST); and Water supply (WS). The information needs of this system include type of water use (by category); name of water user; location of water use (latitude/longitude, county, and hydrologic unit--drainage basin); sources of water supply and return (fresh, saline, or reclaimed surface water or groundwater); volume of water withdrawn, delivered, consumed, released, and returned; and period of water use (month, year). State and local agency personnel collect most of the water use data. Knowledge of the Missouri River basin's water resource availability and utilization through programs such as this can provide necessary and valuable assistance in effective management of water for the benefit of present and future generations. (Lantz-PTT)
W91-07902

WATER DISTRIBUTION: CONFLICTING OBJECTIVES OF SCHEME MANAGEMENT AND FARMERS.
International Inst. for Land Reclamation and Improvement, Wageningen (Netherlands).
M. Jurriens, and W. Landstra.
Annual Report 1989. International Institute for Land Reclamation and Improvement, Wageningen, The Netherlands. 1989. p 38-46, 11 fig, 3 tab, 6 ref.

Descriptors: *Agriculture, *Competing use, *Irrigation management, *Water distribution, *Water resources management, Developing countries, Drought, India, Irrigation, Irrigation practices, Legislation.

The objectives of irrigation schemes are not always explicitly formulated; they can be mutually conflicting, or in conflict with farmers' objectives. Under such circumstances, the management of any organization will be difficult and performance problems are bound to arise. When discussions on irrigation management started in the seventies, this was soon recognized by many authors. Usually, however, the statements made were of a general nature; concrete and detailed elaborations on this issue are hard to find. In India, water requirements are expressed as 'duties', which indicate the area to be irrigated by a unit flow size, usually given in acres/cusec. The duties were said to be additional to rainfall; they consequently differ for the same crops in rabi (dry season) and in kharif (wet season). Moreover, they were considered to be averages for the crop. Theoretically, protective irrigation was thought to be realized by a set of three 'operational targets', viz.: low irrigation intensity; a policy of localization; and high 'duties', or low water allowances. These three elements are discussed in detail, and theory and practice are compared. Some possible remedial measures are: (1) the crop-enforcement aspect in the localization policy must be abandoned; (2) the present system, whereby farmers are supposed to irrigate their part of their land in the wet season and the remaining area in the dry season, should be abolished; (3) the duties will have to be modified to more realistic

values. A higher water supply for a crop will mean that--given the limited available water--the 'notional cropping patterns' will have to contain more crops with low water requirements, at the expense of the paddy; (4) the physical system has to be remodeled and adapted to the needs of the new operational plan; and (5) changes in organization and legislation and a strong political commitment are essential in order to create more possibilities for effective control in implementing the new operational plans. (Lantz-PTT)
W91-07911

OVERVIEW OF WATER FOR ENVIRONMENTAL MANAGEMENT.
Foundation for Research Development, Pretoria (South Africa).
R. D. Walmsley, and B. R. Davis.
Water SA WASADV, Vol. 17, No. 1, p 67-76, January 1991. 7 fig, 2 tab, 40 ref.

Descriptors: *Environmental policy, *South Africa, *Water allocation, *Water resources management, *Water use, Administrative agencies, Carrying capacity, Case studies, Channels, Consumptive use, Ecology, Estuaries, Evaporation, Flushing, Habitats, Minimum flow, National parks, Nonconsumptive use, Parks, Research priorities, Reservoirs, Riparian waters, Rivers, Water resources development, Wetlands, Wildlife.

The current situation in South Africa regarding the allocation of water for management of the environment is reviewed. 'Water for management of the environment' is interpreted to include water which is released in order to maintain a multitude of ecological function within habitats such as wetlands, estuaries, reservoirs, river channels, and riparian zones. Implicit in the term is also the quantity of water required for consumptive and nonconsumptive purposes, including evaporation, flushing-flows, and drinking water for wildlife. Statements on the current policy of the Department of Water Affairs are presented along with four case studies (Pongolo Floodplain, Nyl Floodplain, and Kruger National Park rivers). It is concluded that: (1) river management objectives have not been defined adequately; (2) human carrying capacities have not been taken into consideration during planning and development; (3) there is a paucity of sound ecological research data on which to base management decisions; and (4) minimum flow requirements have not been defined adequately. The ability to make sound management decisions on the problem of water allocation for the environment is hampered by the shortage of trained manpower and the low level of funding for research on minimum flow requirements. Future water resource planning and development will have to take greater cognizance of conservation and environmental issues. (Doria-PTT)
W91-08094

6E. Water Law and Institutions

DEVELOPMENT OF PENNSYLVANIA ENVIRONMENTAL POLICY AND OPPORTUNITIES FOR IMPACT.
For primary bibliographic entry see Field 5G.
W91-07167

POLICY ANALYSIS OF ALBERTA'S HAZARDOUS WASTE MANAGEMENT PROGRAM -- A RESEARCH PERSPECTIVE.
Alberta Special Waste Management Corp., Edmonton.
For primary bibliographic entry see Field 5G.
W91-07168

SEEKING ORDER WITHIN THE CHAOS OF TOXICS LAWS: THE TOXICS PROGRAM MATRICES IN NEW JERSEY AND PENNSYLVANIA.
ENSCO Environmental Services, Inc., Fremont, CA.
For primary bibliographic entry see Field 5G.
W91-07169

RCRA FACILITY INVESTIGATION AND CORRECTIVE MEASURES STUDY PROGRAM: CASE STUDIES.
Weston (Roy F.), Inc., West Chester, PA.
For primary bibliographic entry see Field 5G.
W91-07665

LEGAL AND INSTITUTIONAL ASPECTS OF DROUGHT MANAGEMENT.
Clyde and Pratt, Salt Lake City, UT.
For primary bibliographic entry see Field 3D.
W91-07799

WETLANDS: MITIGATING AND REGULATING DEVELOPMENT IMPACTS.
Urban Land Inst., Washington, DC.
For primary bibliographic entry see Field 2L.
W91-07807

WATER ACT 1989: CHAPTER 15.
Statutes in Force--Official Revised Edition. Report No. Water:130, 1989. Available from Her Majesty's Stationery Office, London. 496p.

Descriptors: *England, *Legislation, *Water Act, Economic aspects, Environmental protection, Flood control, Legal aspects, Navigation, Regulations, Wastewater treatment, Water quality, Water supply.

The Water Act 1989, is an Act to: (1) provide for the establishment and functions of a National Rivers Authority and of committees to advise that Authority; (2) provide for the transfer of the property, rights and liabilities of water authorities to the National Rivers Authority and to companies nominated by the Secretary of State and for the dissolution of those authorities; (3) provide for the appointment and functions of a Director General of Water Services and of customer service committees; (4) provide for companies to be appointed to be water undertakers and sewerage undertakers and for the regulation of the appointed companies; (5) make provision with respect to, and the finances of, the nominated companies, holding companies of the nominated companies and statutory water companies; (6) amend the law relating to the supply of water and the law relating to the supply of water and the law relating to the provision of sewers and the treatment and disposal of sewage; (7) amend the law with respect to the pollution of water and the law with respect to its abstraction from inland waters and underground strata; (8) make new provision in relation to flood defense and fisheries; (9) transfer functions with respect to navigation, conservancy and harbors to the National Rivers Authority; and (10) for connected purposes. (Author's abstract)
W91-07904

6F. Nonstructural Alternatives

FLOOD AND LANDSLIDE HAZARD MAPPING, SOLOMON ISLANDS.
Department of Scientific and Industrial Research, Palmerston North (New Zealand). Div. of Land and Soil Sciences.
For primary bibliographic entry see Field 2E.
W91-07727

MONETIZING EROSION AND SEDIMENTATION COSTS WHERE STEEPLANDS MEET THE SEA.
East-West Environment and Policy Inst., Honolulu, HI.
J. A. Dixon.
IN: Research Needs and Applications to Reduce Erosion and Sedimentation in Tropical Steeplands. IAHS Publication No. 192. International Association of Hydrological Sciences, Washington, DC. 1990. p 195-207. 1 fig, 5 tab, 27 ref.

Descriptors: *Economic aspects, *Erosion, *Erosion control, *Sedimentation, *Soil erosion, Ecosystems, Fisheries, Logging, Productivity, Slope stabilization, Slopes, Tourism, Tropical areas.

Although the financial costs of erosion control measures are usually known or easily calculated, greater uncertainty exists over the size of potential benefits. One way to assess these benefits is to analyze the costs avoided by preventing increased erosion. In a linked economic-ecological analysis these potential costs were estimated for a tropical ecosystem containing steep uplands and an adjacent coast. Three industries are dependent on the ecosystem: logging, a coastal fishery, and a diving-based tourism industry. Estimates were made of the physical links between logging-induced soil erosion and reduced productivity of the fishery and tourism industries. Two options, continued logging and a logging ban, were analyzed. Economic analysis showed that the logging ban generated greater benefits, both financial and social. In order to enforce this ban, however, government intervention is required. Normal market forces would have led to a second best alternative with continued logging and associated erosion-caused damages. (See also W91-07713) (Author's abstract)
W91-07733

DIMENSIONS OF DROUGHT MANAGEMENT FOR PUBLIC WATER SUPPLIES.
Colorado Univ. at Boulder. Inst. of Behavioral Genetics.
For primary bibliographic entry see Field 3D.
W91-07795

CASE STUDIES IN DRAINAGE AND LEVEE DISTRICT FORMATION AND DEVELOPMENT ON THE FLOODPLAIN OF THE LOWER ILLINOIS RIVER, 1890S TO 1930S.
Illinois Univ. at Urbana-Champaign. Dept. of Geography.
J. Thompson.
WRC Special Report No. 016, May 1989. Water Resources Center, University of Illinois, Urbana. 152p, 56 tab, 14 ref.

Descriptors: *Case studies, *Drainage districts, *Flood plain zoning, *Illinois River, Flood plains, Illinois, Illinois River Basin, Levees, Water resources management.

This collection of accounts about the formation and development of the drainage and levee districts that arose along the floodplain of the lower Illinois River between the 1890s and 1930s, was prepared with two objectives in mind. The first was to provide sufficient evidence about the operation of human activities and natural processes to better understand why and how the valley between Peoria and Grafton, Illinois, was transformed from perennial and seasonal wetlands, into a relatively flood-free agricultural landscape of great productivity. The second objective was to provide residents of the counties that share the floodplain and river with a clearer sense of the legacies of the remarkable venture in land drainage. The historical accounts of the drainage and levee districts of the floodplain are supplemented with a handful of studies about adjacent drainage districts. These case studies made possible the development of generalizations about the land drainage experience. Although no synthesis about the land drainage experience along the lower Illinois River can be offered here, a sense of the larger experience may be obtained by reading the case studies. For the browser, an overview is best gained by reading accounts of these districts: Coal Creek, Pekin and LaMarsh, Hillview, Keach, McGee Creek, Big Swan, Nutwood, South Beardstown and Spring Lake. (Lantz-PTT)
W91-07816

6G. Ecologic Impact Of Water Development

DETERMINATIONS OF ELIGIBILITY FOR SEVEN BUREAU OF RECLAMATION DAMS IN THE PACIFIC NORTHWEST REGION: DEADWOOD DAM, GRASSY LAKE DAM, MCKAY DAM, CRANE PRAIRIE DAM, WICKIUP DAM, OWYHEE DAM, AND AGENCY VALLEY DAM.

Renewable Technologies, Inc., Butte, MT.
F. L. Quivik, and J. A. Hess.
September 1989. 147p, 94 fig, 151 ref. Bureau of Reclamation Contract No. 9-CS-10-09250.

Descriptors: *Dams, *History, *National Register of Historic Places, Agency Valley Dam, Concrete-arch dams, Crane Prairie Dam, Deadwood Dam, Grassy Lake Dam, McKay Dam, Owyhee Dam, Social aspects, Wickiup Dam.

This report constitutes the recommendations of a private firm concerning determinations of eligibility for listing in the National Register of Historic Places for seven Bureau of Reclamation dams located in Oregon, Idaho, and Wyoming. The dams are: Agency Valley, Crane Prairie, McKay, Owyhee, and in Wickiup in Oregon; Deadwood in Idaho; and Grassy Lake in Wyoming. Owyhee Dam has already been determined eligible for the National Register, but documentation for that earlier determination was minimal. This report provides documentation meeting National Register standards. Documentation includes an historic context: Bureau of Reclamation Dams in the Pacific Northwest, 1905-1948. The evaluations leading to this report have yielded recommendations that Agency Valley, McKay, Owyhee, Wickiup, Deadwood, and Grassy Lake dams are eligible for listing in the National Register; Crane Prairie Dam is not eligible. (Author's abstract)
W91-07197

WATER QUALITY OF SELECTED TAILWATERS.
Ouachita Baptist Univ., Arkadelphia, AR. Dept. of Chemistry.
For primary bibliographic entry see Field 5B.
W91-07199

ECOLOGICAL CONSEQUENCES OF DREDGING AND BOTTOM TRAWLING IN THE LIMFJORD, DENMARK.
Vandkvalitetsinstitutet, Hoersholm (Denmark).
B. Riemann, and E. Hoffmann.
Marine Ecology Progress Series MESEDT, Vol. 69, No. 1/2, p 171-178, January 10, 1991. 8 fig, 2 tab, 19 ref.

Descriptors: *Denmark, *Dredging, *Ecological effects, *Ecosystems, *Fjords, *Limfjord, *Marine fisheries, *Particulate matter, *Trawling, Air temperature, Ammonia, Nutrient concentrations, Nutrient transport, Oxygen, Phytoplankton, Suspended solids, Water sampling, Wind speed.

During August 1988, effects of mussel dredging and bottom trawling on particulate material, internal nutrient loads, and oxygen balance were examined at 3 shallow locations in Limfjorden, Denmark. Water samples were taken simultaneously from areas exposed to fishing activities and from unused control areas. Sampling was carried out before fishing and 0 (immediately after fishing), 30, and 60 min after fishing. Sampling and control areas, which were situated close to one another, each covered 160,000 sq m and included 9 sampling stations and 3 depths. Immediately after mussel dredging, suspended particulate material increased significantly, but 30 min after dredging these differences had decreased and had returned to the start level after 60 min. The effect per dredged sq m (1850 sq m) extrapolated to the total area was 1470 g suspended particulate material per sq m dredged, corresponding to an increase of 1361% on the average suspended particulate material in the water column before dredging. Similar values for eel trawling from 2 different stations gave 960 and 1000%, respectively. Oxygen decreased significantly after mussel dredging and average ammonia content increased, but large horizontal variations in the ammonia content prevented detailed interpretation of these increases. Changes in other nutrients were small. Changes in particulate matter and nutrients were also observed at 2 stations on a day with high followed by a day with low wind velocity. Particulate matter and total phosphorus were markedly higher on the windy day. A significant proportion of dredging and trawling in the Limfjord takes place during the summer, when wind speed are mostly low, nutrients are low, and oxygen consumption and temperatures are high. During these periods, trawling and particularly dredging reduce the water quality by increasing internal nutrient loads, oxygen consumption, and possibly phytoplankton primary production. (Author's abstract)
W91-07329

SHRIMP STOCKING, SALMON COLLAPSE, AND EAGLE DISPLACEMENT.
Montana Univ., Polson. Flathead Lake Biological Station.
C. N. Spencer, B. R. McClelland, and J. A. Stanford.
Bioscience BISNAS, Vol. 41, No. 1, p 14-21, January 1991. 8 fig, 2 tab, 56 ref.

Descriptors: *Birds, *Ecological effects, *Introduced species, *Limnology, *Opossum-shrimp, *Salmon, *Water resources management, Aquatic environment, Copepods, Crustaceans, Fish, Flathead Lake, Food chains, Lake ecology, Mammals, Montana, Predation, Resources management, Rivers, Shrimp, Stream biota, Tributaries, Waterfleas.

Studies have reported the negative effects of introducing nonnative fish and fish-food organisms. Widespread changes are documented cascading through the food web of the Flathead River-Lake ecosystem (Montana) after the introduction of the opossum shrimp Mysis relicta with the intention of enhancing kokanee salmon. Owing to predation by the shrimp, copepod and cladoceran populations declined dramatically, contributing to the collapse of an important planktivorous fish population. Loss of this formerly abundant forage fish caused displacement of birds and mammals that had fed on them in an upstream tributary within Glacier National Park. It is expected that the Flathead Lake food web will shift from pelagic kokanee salmon toward benthic-feeding fish species, which can exploit the abundant daytime opossum shrimp concentrations on the lake bottom. Opossum shrimp and zooplankton population will probably continue to exhibit cyclic oscillations characteristic of some predator-prey interactions. It is likely that many bald eagles will gradually shift their southward migration route away from the area in search of alternate prey. Stricter controls are needed to prevent further introductions, particularly until we can predict cascading effects within food webs of aquatic ecosystems. (Doria-PTT)
W91-07381

LIFE HISTORY NOTES AND DISTRIBUTION OF THE JOHNNY DARTER, ETHEOSTOMA NIGRUM (PERCIDAE), IN COLORADO.
New Mexico Dept. of Game and Fish, Santa Fe.
D. L. Propst, and C. A. Carlson.
Southwestern Naturalist SWNAAB, Vol. 34, No. 2, p 250-259, 1989. 2 fig, 1 tab, 28 ref.

Descriptors: *Colorado, *Darters, *Ecological distribution, *Ecological effects, *Fish populations, *Stream biota, Channeling, Drainage, Farm wastes, Food habits, Growth, Habitats, Life cycles, Lotic environment, Midges, River basins, Sediment transport, Shallow water, Spawning, Water pollution effects.

The johnny darter, Etheostoma nigrum, reaches the western limits of its native range in the Platte River drainage of Northeastern Colorado. In the South Platte River basin, it historically occurred throughout foothill stream reaches, but anthropogenic modifications have reduced its range in many streams and eliminated it from some. The species was most frequently found in shallow, slow-velocity water over a cobble-sand substrate. Chironomid larvae were its most important food item throughout the year. Spawning peaked in July to early August. Development was rapid in the first year of life, and most growth was attained by the second summer. On the western periphery of its rather extensive range, the johnny darter remains comparatively common in lotic habitats that have not been drastically modified by human activity. Where stream habitats have been altered by channelization, urban and agricultural wastes and effluents, and unseasonably high sediment transport, the johnny darter is absent or rare. Although the scant historic record does not permit a precise description of the historic range and abundance of the species in Colorado, the record is sufficient to indicate a general decline in the status of the johnny darter since European settlement of the Platte River basin. (Author's abstract)
W91-07400

VEGETATION AND FLORA OF OPENED HYDROPHYTIC AREAS: DAMS AND STREAM SWAMPS IN THE CENTRE-EAST OF IVORY COAST (VEGETATION ET FLORE DE MILIEUX HYDROPHYTIQUE OUVERTS: BARRAGES ET BASFONDS DE RIVIERES, DU CENTRE-EST DE LA COTE-D'IVOIRE).
Universite Nationale de Cote d'Ivoire, Abidjan. Lab. de Botanique.
D. Traore, G. Anoma, and W. Egnankou.
Candollea CNDLAR, Vol. 45, No. 2, p 423-438, 1990, 5 photo, 5 fig, 3 tab, 9 ref. English summary.

Descriptors: *Aquatic plants, *Dam effects, *Ivory Coast, *Limnology, *Reservoirs, *Swamps, *Vegetation establishment, Agricultural water, Aquatic weeds, Floating plants, Sedges, Species composition, Water supply.

The Ivory coast has constructed six hydroelectric dams and over 400 dams which supply agricultural water. Dams were built at Abengourou, Agnibilekro and Daoukro to supply potable water in the central eastern part of the Ivory Coast. The original plants which inhabited the regions of these dams have died and been replaced with plants which prefer wet, humid environments. The encroachment of these plants has hindered the use of these dams. Investigations were carried out at Daoukro, Abengourou and Agnibilekro. At Dauokro, invading species are living primarily on drained soil. The twenty-one other taxons are found in aquatic, humid environments. The floating mats of vegetation are primarily composed of Pycreus mundtii. At Abengourou, Pycreus mundtii and Fuirena umbellata essentially make up the floating mats of vegetation. (King-PTT)
W91-07527

CHANGE OF WATER ENVIRONMENT IN YANGZHUOYONG LAKE, TIBET (IN CHINESE).
Sichuan Research and Monitoring Inst. of Environmental Protection, Chengdu (China).
X. P. Chen.
Oceanologia et Limnologia Sinica (Hai Yang Yu Hu Chao) HYHCAG, Vol. 21, No. 3, p 285-292, July 1990, 1 fig, 6 tab, 3 ref. English summary.

Descriptors: *Environmental effects, *Hydroelectric power, *Limnology, *Salinity, *Tibet, *Water quality, *Water quality trends, *Water resources development, China, Hydrologic budget, Mass balance, Mineralization, Model studies, Yangzhuoyong Lake.

Yangzhuoyong Lake is a large enclosed lake in Tibet with a capacity of 14,300 million cu m and has a mineralization of 1900 mg/L. The amount of water entering lake is basically in balance with the amount of evaporation. The lake can be exploited for the generation of electricity by using the potential energy difference between the level of the lake and the level of the Yarluzangbu River. The changes in water capacity and the mineralization after exploiting the lake were calculated using the mass balance of the water and a zero-dimensional model of water quality. Mineralization would not change significantly, but the lake area would decrease 121.4 cu km after 67 years. If water is used for power generation, the salinity of the lake will gradually decrease; otherwise, it will continue to increase. (Author's abstract)
W91-07536

EFFECTS OF WATER ENGINEERING MEASURES ON THE STRUCTURE OF BIOCENOSES AND ON THE CONTENT OF NOXIOUS POLLUTANTS IN THE DANUBE.
Bayerische Landesanstalt fuer Landtechnik,

Munich (Germany, F.R.).
B. Wachs.
Zeitschrift fuer Wasser- und Abwasser-Forschung ZWABAQ, Vol. 23, No. 5, p 173-178, October 1990, 1 tab, 43 ref.

Descriptors: *Austria, *Dam effects, *Danube River, *Environmental impact, *Stream biota, *Stream pollution, *Water resources development, Benthic fauna, Flow control, Hydroelectric plants, Oligochaetes, Reservoirs, Species diversity, Thermal pollution.

The simultaneous development and protection of the Danube's water resources will increasingly require interdisciplinary cooperation regarding ecological problems. In the 1980s, it was recognized that the storage reservoirs of the hydroelectric power plants in Austria have had positive effects on the self-cleaning capacity of the Danube. As the tubificid population has increased along with the growing supply of organic material in the sediment, it has contributed considerably to self-purifying processes in the vicinity of powerplant dams. These oligochaetes also help clean up strongly polluted areas, provided that conditions are not too toxic. However, a closer look at the benthic fauna reveals a considerable loss of species diversity, due mainly to the loss of sewage-avoiding species. Within a year of the impoundment of the nearly-300-km-long Iron Gate Reservoir, almost 50% of the benthic animal species disappeared due to changes in ecological conditions. In the future, more attention should be paid to thermal loading of the Danube by the discharge of cooling water from powerplants; there will be unavoidable water-temperature increases in the upper and middle Danube. Also, since remobilization of heavy metals and other harmful substances from the organic material of the sediments can occur during periods of high water, optimal water level should be maintained in all seasons. (King-PTT)
W91-07540

ECOLOGY AND HYDRAULICS IN THE FUTURE.
For primary bibliographic entry see Field 8A.
W91-07875

COMPREHENSIVE EXPERT EVALUATION OF THE ECOLOGICAL CONSEQUENCES OF THE CONSTRUCTION OF HYDROPOWER FACILITIES.
For primary bibliographic entry see Field 8A.
W91-07876

WATER AND SALT REGIME OF THE ARNASAI LAKES.
A. K. Kiyatkin, S. I. Shaporenko, and M. V. Sanin.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 3, p 172-177, 1990. 3 fig, 4 tab, 5 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 3, p 15-18, March, 1990.

Descriptors: *Environmental impact, *Irrigation programs, *Irrigation-return flow, *Saline lakes, *Salinity, *Soviet Union, *USSR, *Water pollution effects, Aral Sea, Arnasai Lakes, Lake fisheries, Mathematical models, Salt balance, Syr Darya River.

The solution of problems of the radical reconstruction of irrigation systems in the Aral Sea basin and particularly in the territory of the lower course of the Syr Darya will substantially change the conditions of feeding and regime of one of the largest water bodies storing runoff, the Arnasai Lake system. Therefore, a study of the water and salt regime of this lake system is important not only from a theoretical but from a practical point of view. Since 1969, when the Arnasai Lakes were used as a water a receiver during retarding of the disastrous Syr Darya flood by the Charadara reservoir, the water and salinity regime became established according to the unique conditions existing in the basin. During the mid-1970s evaporation was about two times greater than the volume of collector-drainage waters being discharged, the level in the lakes dropped and in 1976 stabilized at elevations close to 235 m BS. From the late 1970s-early 1980s period, more water has entered and lake volume began to increase. Salt balance calculations showed that during the period of lake formation (1969-1970) about half of the salt that had accumulated in the lakes entered due to leaching from the bed of the lakes during dissolution of the playas. The entry of salts with wastewaters from the Charadara reservoir was the second most important element in the balance. The collector-drainage runoff became the dominant component of the salt balance during stabilization of the water regime of the lake. The change in the volumes of the Arnasai Lakes and dynamics of salt accumulation show that during the 17 years since 1968 the amount of salt increased 37 times and at the end of 1985 exceeded 140 million tons. During this period the average mineralization of the lake water increased by more than three times and was 10.12 g/L. Increased mineralization of water in the Arnasai Lake system reduced natural fish productivity and changed the composition of the commercial fish catches. (Rochester-PTT)
W91-07879

POLICY AND PRACTICE IN THE MANAGEMENT OF TROPICAL WATERSHEDS.
H. C. Pereira.
Westview Press, Boulder, Colorado. 1989. 237p.

Descriptors: *Environmental protection, *Land use, *Policy making, *Tropical regions, *Water resources management, *Watersheds, Developing countries, Economic aspects, Energy, Erosion control, Irrigation, Revegetation, Rural areas.

Misuse of land on tropical watersheds in developing countries is increasing rapidly in association with accelerating population growth and the accompanying poverty. Destruction of natural vegetation without replacement by productive agriculture or forestry imposes severe penalties of soil erosion and sediment transport. Sedimentation destroys reservoir storage capacity and inhibits investment in power generation and irrigation. Tropical meteorological events create seasonal water surpluses that produce floods in the lowlands. Every corrective step to arrest watershed degradation improves the welfare of the inhabitants, both rural and urban: (1) restoration of a productive and protective tree cover on steep slopes can provide the fuelwood to forestall the impending crisis in the supply of domestic energy in developing countries; and (2) planting of fodder and control of livestock can improve animal productivity and increase the supply of manure available for crops. In this book, restoration of vegetation and fuelwood are described in plain language and successful examples are quoted. Where it has been possible to assess costs and benefits, examples are quoted. Distribution of water from irrigation canals between farms and within farms has been neglected as an aspect of management so that severe water losses and waterlogging occur widely. National, international, bilateral, and nongovernment agencies are making important contributions to the correction of watershed misuse, but are not coordinated either by country or by watershed. The national governments of tropical developing countries are not yet giving priority to rural area development in spite of growing food shortages. (Lantz-PTT)
W91-07907

WORLD RESOURCES: 1990-91.
World Resources Inst., Washington, DC.
Oxford University Press, New York. 1990. 383p.

Descriptors: *Climatic changes, *Environmental quality, *Urban hydrology, *Water resources, *World resources, Climates, Climatic data, Data collections, Environment, Environmental data, Environmental protection, Geography, Global warming.

The 'World Resources' series is intended to meet the critical need for accessible, accurate information on the management of natural resources and protection of the global environment. This volume of 'World Resources' contains information on resource use and environmental issues around the world. Part I gives an overview of topics that stand out as having a pervasive impact on the human condition, exerting unique leverage on the future of the planet, or requiring urgent action. Part II includes a chapter on global climate change, and includes the first publication of the Greenhouse Index, which tracks each country's current responsibility for greenhouse gas emissions. Part II also includes an overview of resource use and environmental problems in Latin America--from deforestation to urban pollution--continuing and expanding on a tradition of examining in each volume a particular geographical region in more detail. Both the potential impact of climate change and Latin America resource issues are discussed in additional sections throughout the volume. Part III reports on basic conditions and trends, major problems and efforts to resolve them, and recent developments in each of the major resource categories, from population and health to energy and freshwater. Supporting data, as well as the core data tables from the World Resources Database, are found in Part IV. (Lantz-PTT)
W91-07919

EVALUATION OF THE ECOLOGICAL AND WATER MANAGEMENT SITUATION IN CENTRAL ASIA BASED ON DATA OF AERIAL AND SATELLITE SURVEYS.
For primary bibliographic entry see Field 3F.
W91-08034

CHANGE OF THE LIFE CYCLE OF JAPANESE CHARR FOLLOWING ARTIFICIAL LAKE CONSTRUCTION BY DAMMING.
Hokkaido Univ., Sapporo (Japan). Faculty of Agriculture.
S. Nakano, K. W. Maekawa, and S. Yamamoto.
Nippon Suisan Gakkaishi (Bull Jpn Soc Sci Fish) NSUGAG, Vol. 56, No. 12, p 1901-1905, December 1990. 3 fig, 1 tab, 20 ref.

Descriptors: *Char, *Dam effects, *Fish behavior, *Fish populations, *Japan, *Life cycles, Artificial lakes, Dams, Fish, Fish migration, Reproduction, Spawning.

Several reproductive characteristics of two types of Japanese char (Salvelinus leucomaenis) found in Arimine Lake, an artificial lake-inlet stream system in Toyama, Japan, were studied. Larger-sized individuals, which migrate downstream to the lake and grow to maturity there, later migrate up several inlet streams to spawn. Smaller-sized individuals, however, are resident in streams and spawn there. These types are respectively similar to sea-run or lake-run and stream resident types of other salmonid fish. During the 26 years following lake construction by damming, the migratory life cycle part of the population of this char appears to have changed from the fluvial form. From records of body size observed during spawning, two tendencies were evident: Females and males presumably form pairs based on body type, and males of the smaller type and subordinates of the larger type tend to spawn as satellites or sneakers. This pattern has been seen in other salmonid fish with stream resident types. Since their body size was usually smaller than that of the paired males, evolutionary theory suggests that they require this alternative mating strategy. The significant correlation of body size between females and males of each pair suggests mating to be assortative by body size at pair formation, as reported in other salmonids. (Author's abstract)
W91-08082

7. RESOURCES DATA

7A. Network Design

UPDATES TO THE 1986 DIRECTORY OF PRECIPITATION MONITORING SITES NATIONAL ATMOSPHERIC DEPOSITION PROGRAM/NATIONAL TRENDS NETWORK (NADP/NTN).
Colorado State Univ., Fort Collins. Natural Resource Ecology Lab.
For primary bibliographic entry see Field 7B.
W91-07217

WATER-RESOURCES DATA-NETWORK EVALUATION FOR MONTEREY COUNTY, CALIFORNIA, PHASE 3: NORTHERN SALINAS RIVER DRAINAGE BASIN.
Geological Survey, Sacramento, CA. Water Resources Div.
W. E. Templin, and R. C. Schluter.
Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4123, 1990. 96p, 9 fig, 12 tab, 77 ref.

Descriptors: *Data acquisition, *Data collections, *Network design, *North Salinas River Basin, *Water resources data, Aquifers, California, Chlorides, Groundwater quality, Nitrates, Rain gages, Specific conductivity, Streamflow, Water quality.

Water resources data collection networks were evaluated in the northern Salinas River drainage basin, Monterey County, California. The evaluation covers quantity and quality monitoring by precipitation, surface water, and groundwater networks. The study identified 34 precipitation gages in the study area, of which 20 are active, and 10 streamflow gaging stations, of which 6 are active. The Monterey County Flood Control and Water Conservation District samples one surface water site for suspended sediment, specific conductance, and chlorides. Several agencies have done water quality sampling in the past, but only five sites are active. Reactivation of the 34 inactive sites might help to meet the various surface water quality objectives described in the report. The Monterey County Flood Control and Water Conservation District also maintains three networks to measure groundwater levels on a monthly basis, during peak irrigation, and at the end of the irrigation season. The District measures water levels in 318 wells. The ideal initial baseline network of groundwater quality wells would be an evenly spaced grid of index wells within each aquifer, with a density of one per section. Once baseline conditions were established, representative wells could be selected and monitored annually. As of 1985, the Monterey County Flood Control and Water Conservation District monitored 379 study wells in the area for various water quality conditions. Other networks monitor (or propose the monitoring of) 135 wells. The District collects samples in summer months to monitor saltwater intrusion near Castroville. Annual samples also are analyzed for chloride, specific conductance, and nitrate. Every 5 years, the District does a complete mineral analysis on each study well. Improvements in network coverage are suggested to better approximate ideal network coverage. The adequacy of wells in existing monitoring networks for representing actual conditions in the groundwater basins was not established conclusively. Possible redundancy of information from existing networks was not evaluated statistically. Despite these limitations, this report does provide a basis for assessing the adequacy of groundwater level networks in the study area. (Lantz-PTT)
W91-07819

WELL INSTALLATION AND DOCUMENTATION, AND GROUND-WATER SAMPLING PROTOCOLS FOR THE PILOT NATIONAL WATER-QUALITY ASSESSMENT PROGRAM.
Geological Survey, Reston, VA.
M. A. Hardy, P. P. Leahy, and W. M. Alley.
Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Open File Report 89-396, 1989. 36p, 2 fig, 9 tab, 32 ref.

Descriptors: *Data acquisition, *National Water-Quality Assessment Program, *Quality control, *Site selection, *Standards, *Water quality, *Wells, Field tests, Well construction.

Several pilot projects are being conducted as part of the National Water-Quality Assessment (NAWQA) Program. The purpose of the program is to test and refine concepts for a proposed full-scale program. Three of the pilot projects are specifically designed to assess groundwater. The purpose of this report is to describe the criteria that are being used in the NAWQA pilot projects for selecting and documenting wells, installing wells, and sampling wells for different water quality constituents. Guidelines are presented for the selection of wells for sampling. Information needed to accurately document each well includes site characteristics related to the location of the well, land use near the well, and important well construction features. These guidelines ensure the consistency of the information collected and will provide comparable data for interpretive purposes. Guidelines for the installation of wells are presented and include procedures that need to be followed for preparations prior to drilling, the selection of the drilling technique and casing type, the grouting procedure, and the well-development technique. Information needed to adequately document the installation of these wells is presented. A major component of the protocols is related to water quality sampling. Tasks are identified that need to be completed prior to visiting the site for sampling. Guidelines are presented for purging the well prior to sampling, both in terms of the volume of water pumped and the chemical stability of field parameters. Guidelines are presented concerning sampler selection as related to both inorganic and organic constituents. Documentation needed to describe the measurements and observations related to sampling each well and treating and preserving the samples are also presented. Procedures are presented for the storage and shipping of water samples, equipment cleaning, and quality assurance. Quality assurance guidelines include the descriptions of the general distribution of the various quality-assurance samples (blanks, spikes, duplicates, and reference samples) that will be used in the pilot program. (Lantz-PTT)
W91-07824

SURFACE WATER QUALITY MONITORING AND POLLUTION CONTROL IN GHANA.
Water Resources Research Inst., Accra (Ghana).
S. A. Larmie, R. A. Osafo, and N. B. Ayibotele.
Water Science and Technology WSTED4, Vol. 24, No. 1, p 35-41, 1991. 3 fig, 1 tab, 7 ref.

Descriptors: *Developing countries, *Ghana, *Monitoring, *Network design, *Water pollution control, *Water quality monitoring, Economic aspects, Industrial wastes, Law enforcement, Legal aspects, Legislation, Planning, Quality control, Water pollution, Water pollution sources, Water quality standards, Water use.

Surface water pollution in increasing in Ghana. Meanwhile, financial resources or the technology to combat serious water quality problems may not be available or adequately developed. The failure of most industrial concerns to even partially treat their effluents is due to the absence of appropriate legislation and enforcement. An adequate system of monitoring is a vital instrument in the pollution control process. A water quality monitoring program begun in 1985 has the following goals: (1) a review and analysis of all available existing data on surface waters; (2) the design of a network to monitor and assess surface water quality taking into account specific quality problems in the areas of domestic, municipal, industrial, and agricultural water use; (3) the preparation of a program and plan for implementing the network based on collaborative action among the different water and related agencies; and (4) implementation of the network to generate consistent data for national water quality standards to be incorporated into legislation. Although progress has been made, more work needs to be done. Legislative procedures and environmental impact assessment methods need to be developed. Analytical quality control will play a prominent role in water laboratory activities. (Doria-PTT)
W91-08063

7B. Data Acquisition

IMPLICATIONS OF ENHANCED BIODEGRADATION FOR THE USE AND STUDY OF PESTICIDES IN THE SOIL ENVIRONMENT.
DowElanco, Midland, MI. Environmental Chemistry Lab.
For primary bibliographic entry see Field 5B.
W91-07138

IN SITU SOIL BIOREMEDIATION: THE INTERFACE BETWEEN BIOLOGY AND ENGINEERING.
Biodetox, Inc., Newark, DE.
For primary bibliographic entry see Field 5G.
W91-07183

SELECTED TOOLS AND TECHNIQUES FOR PHYSICAL AND BIOLOGICAL MONITORING OF AQUATIC DREDGED MATERIAL DISPOSAL SITES.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
For primary bibliographic entry see Field 5G.
W91-07191

USEPA MANUAL OF METHODS FOR VIROLOGY. CHAPTER 7, REVISED SEPTEMBER 1989.
Environmental Monitoring and Support Lab.-Cincinnati, OH.
For primary bibliographic entry see Field 5A.
W91-07208

U.S. GEOLOGICAL SURVEY FEDERAL-STATE COOPERATIVE WATER-RESOURCES PROGRAM, FISCAL YEAR 1989.
Geological Survey, Reston, VA.
B. K. Gilbert, and W. B. Mann.
Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. Open-File Report 90-353, 1990. 49 p, 2 fig, 6 ref, 3 append.

Descriptors: *Data acquisition, *Geological surveys, *Information retrieval, *Water resources data, Economic aspects, Federal jurisdiction, Hydrologic data, Interagency cooperation, State jurisdiction, Water quality, Water supply.

The USGS Federal-State Cooperative Water-Resources Program (50:50 matching of funds) has responded to national needs for hydrologic information since 1895. During FY 1989, water resources data collection, investigations, and research were conducted in cooperation with more than 1,000 local, State, and regional agencies in every State, Puerto Rico, and several territories. Total funding in the Cooperative Program in FY 1989 amounted to about $126 million and accounted for more than 40% of the total obligations for the Geological; Survey's Water Resources Division. The Cooperative Program provides much of the information required by those responsible for water resources planning and management, water supply development, and environmental improvement through hydrologic data collection, investigations and research. The program is a unique activity in that, although the cooperating agencies provide more than half the funds, the Geological Survey accomplishes most of the work. The program also is the source of much of today's knowledge concerning techniques for collection and analysis of the quantity, quality, and movement of surface and groundwater. Because the availability of water of suitable quality is a fundamental limiting factor in an expanding economy, a comprehensive and forward looking data collection and investigation operation is imperative for planning the best development and use of the Nation's water resources. The job is too large to be supported at either federal or state level alone. The jointly planned and funded Cooperative Program provides convincing assurance that the work is designed to meet both national and local needs. (Lantz-PTT)
W91-07210

UPDATES TO THE 1986 DIRECTORY OF PRECIPITATION MONITORING SITES NATIONAL ATMOSPHERIC DEPOSITION PROGRAM/NATIONAL TRENDS NETWORK (NADP/NTN).
Colorado State Univ., Fort Collins. Natural Resource Ecology Lab.
May 30, 1990. 63p.

Descriptors: *Directories, *Network design, *Precipitation, Data acquisition, Data collections, Monitoring, National Atmospheric Deposition Program, National Trends Network, Networks, Research priorities, Surveys.

The information in this document reflects the status of the National Atmospheric Deposition Program/National Trends Network (NADP/NTN) as of May 30, 1990. It is based, in part, on a thorough review of site location information, which involved verifying latitudes and longitudes determined from 1:24,000 scale topographic maps, and contacting sites to verify dates and distance of site moves and equipment relocations. The computer database at the NADP/NTN Coordination Office was used to identify changes in site owners, sponsors, and operating agencies, and network affiliations. No attempt was made to conduct a comprehensive review of the remaining categories of information in the original directory; however, if the Coordination Office was notified of changes to information in these categories, the updated information is reported in this document. A questionnaire distributed to the sites in the fall of 1989 yielded a considerable amount of new information about research activities at the sites. The information from the 151 sites that responded to the questionnaire is included in this report. Descriptive information for sites established after 1986 is also provided. The format for the description of new sites is similar to that in the original directory; however, funding limitations precluded the printing of site photographs and topographic maps, or the production of emissions plots. (Lantz-PTT)
W91-07217

SPATIAL VARIABILITY OF APPARENT ELECTRICAL CONDUCTIVITY.
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Water and Land Resources.
B. G. Williams, D. P. Richardson, and J. Walker.
Technical Memorandum 90/6, June 1990. 17p, 13 fig, 6 ref.

Descriptors: *Conductivity, *Data acquisition, *Electrical studies, *Geophysical surveys, *Soil properties, *Spatial variation, Agriculture, Electromagnetic waves, Saline soils, Soil water.

Soils are better known for their horizontal and vertical heterogeneity than for any other characteristic of agricultural significance. Relatively small differences in soil texture, moisture characteristics, soluble salt content or fertility status can cause marked variations in crop or pasture production over distances of a few meters. This results in a number of problems for agricultural production and for agricultural research and has resulted in generalizations in interpretation that may disadvantage both. A major problem in coming to grips with this situation is the cost of obtaining adequate objective descriptions of the inherent variability of soils over areas of significance to agricultural production. This is partly resolved by the use of rapid electromagnetic induction techniques for determining the apparent electrical conductivity (ECa) of soils over depths ranging from < 1 m to > 15 m. Although not a specific surrogate measure of texture, soil water or soluble salt content it does delineate quite accurately relative changes in one or more of these variables from site to site within the surveyed area. The accuracy of interpretation of the spatial variability of ECa values then depends on the amount of corroborative measurements that can sensibly be gathered. Therefore, the technique should be used to identify sites for detailed sampling rather than as a definitive measurement of a single soil parameter. (Author's abstract)
W91-07221

WATER QUALITY ENRICHMENT TECHNIQUES USED WITHIN THE CORPS OF ENGINEERS.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
For primary bibliographic entry see Field 5G.
W91-07238

ESTIMATING WATER QUALITY FROM GEOPHYSICAL LOGS.
Geological Survey, Denver, CO. Water Resources Div.
D. G. Jorgensen.
IN: Geophysical Applications for Geotechnical Investigations. STP 1101. American Society for Testing Materials, Philadelphia, PA. 1990. p 477-64, 9 fig, 29 ref, 2 append.

Descriptors: *Borehole geophysics, *Geophysical methods, *Geophysics, *Groundwater quality, *Logging (Recording), *Water quality, Chlorides, Conductivity, Data interpretation, Dissolved oxygen, Hydrogen ion concentration, Mathematical analysis, Resistivity, Temperature, Water chemistry.

Borehole geophysical logs can be used to obtain information on water quality and water chemistry. Water quality characteristics that normally are measured directly in water filled holes or wells include: chloride, dissolved oxygen, pH, temperature, and conductivity. In situ groundwater may exist at some distance adjacent to the borehole, and estimates of water quality or water chemistry can be made by measuring the resistivity or specific electrical conductivity of the water in pore spaces. Most geophysical logs, however, are made in test holes filled with drilling fluid. In this environment, logs enabling estimates of water resistivity (Rw) are useful. Relations among Rw and dissolved solids, sodium chloride solutions, and temperature are well established for saline waters; for freshwater, however, the activities of other dissolved ions also need to be considered. The spontaneous potential (SP) is a function of activity of the mud filtrate and water resistivity and, thus, can be used to estimate Rw. Two methods of estimating Rw are useful: the SP method, which uses data from a SP log and a resistivity log, and the cross-plot method, which uses log-derived porosity and resistivity log data. The application of SP logs depends upon the water quality contrast between the water in the pores (Rw) and the mud filtrate on the borehole wall. Both methods estimate Rw to about a half order of magnitude. However, the accuracy of both methods can be greatly improved if additional data, such as a chemical analysis, can be correlated to a log. (Author's abstract)
W91-07240

TRIAXIAL- AND UNIAXIAL-COMPRESSION TESTING METHODS DEVELOPED FOR EXTRACTION OF PORE WATER FROM UNSATURATED TUFF, YUCCA MOUNTAIN, NEVADA.
Colorado School of Mines, Golden. Dept. of Geology.
For primary bibliographic entry see Field 2G.
W91-07243

EVALUATION OF SINGLE BOREHOLE HYDROTESTS IN FREQUENCY DOMAIN BY A UNIVARIATE STATISTICAL METHOD.
Stuttgart Univ. (Germany, F.R.). Inst. fuer Wasserbau.
For primary bibliographic entry see Field 2F.
W91-07260

SEQUENTIAL APPROACH TO GROUNDWATER MONITORING AND MANAGEMENT.
Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.
For primary bibliographic entry see Field 4B.
W91-07301

QUANTIFYING EXTERNAL AND INTERNAL NITROGEN AND PHOSPHORUS POOLS, AS WELL AS NITROGEN AND PHOSPHORUS SUPPLIED THROUGH REMINERALIZATION, IN COASTAL MARINE PLANKTON BY MEANS OF A DILUTION TECHNIQUE.
Oslo Univ. (Norway). Dept. of Biology.
For primary bibliographic entry see Field 2K.
W91-07322

NEW TECHNIQUE FOR MEASURING VOLUMETRIC SHRINKAGE IN SOILS.
Rocky Mountain Forest and Range Experiment Station, Tempe, AZ. Forestry Sciences Lab.
S. T. Overby, and L. F. DeBano.
Soil Science Society of America Journal SSSJD4, Vol. 54, No. 6, p 1797-1799, November/December 1990. 1 tab, 11 ref.

Descriptors: *Laboratory methods, *Soil drying, *Soil physical properties, *Soil shrinkage, *Soil water, Comparison studies, Economic aspects, Mercury, Shrinkage, Silicon, Soil physics, Statistical analysis, Water displacement.

Volumetric shrinkage (the loss of pore water during drying) and swelling (during wetting) in soils is an important physical parameter used in soil erosion and soil mechanics studies. Shrinking and swelling in several soil layers was examined while studying pipe erosion in New Mexico. The American Society for Testing Materials D427 method for determining volumetric shrinkage was modified using a less toxic silicone-mineral spirits mixture instead of liquid mercury. The volume of the dry soil pat was determined by (1) immersing the pat in a glass cup filled with mercury and (2) treating the same pat with a mixture of silicon and mineral spirits before determining its volume by water displacement. Statistical differences in volumetric shrinkage between the two methods were tested using Student's t-test. The silicone-mineral spirits method yielded the same results in shrinkage as measured by the mercury method for a wide range of soils containing between 22 and 48% clay, and was more economical. Use of the silicone-mineral spirits mixture decreases safety hazards associated with liquid mercury and is more economical. (Brunone-PTT)
W91-07360

DETERMINATION OF URANIUM IN SOLUTION AT THE NG/L LEVEL BY TIME-RESOLVED LASER-INDUCED SPECTROFLUORIMETRY: APPLICATION TO GEOLOGICAL SAMPLES.
CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses (France).
For primary bibliographic entry see Field 2K.
W91-07367

GREAT DISMAL SWAMP: AN ILLUSTRATED CASE STUDY.
Geological Survey, Reston, VA.
For primary bibliographic entry see Field 2H.
W91-07431

DIRECT DETERMINATION OF COMPLEXING CAPACITY OF ORGANIC MATTER DISSOLVED IN HUANGHE ESTUARY WATER BY THE HUANGHE ESTUARY SEDIMENT-ION EXCHANGE METHOD (IN CHINESE).
Ocean Univ. of Qingdao (China).
For primary bibliographic entry see Field 2K.
W91-07535

CHLOROPLAST BIOASSAY FOR THE DETERMINATION OF HERBICIDES IN WATER--AN IMPROVED ELECTRON ACCEPTOR SYSTEM (CHLOROPLASTEN-BIOTEST ZUR HERBIZIDBESTIMMUNG IM WASSER--OPTIMIERUNG DES ELEKTRONENAKZEPTORSYSTEMS).
ESWE-Inst. fuer Wasserforschung und Wassertechnologie G.m.b.H., Wiesbaden (Germany, F.R.).
For primary bibliographic entry see Field 5A.
W91-07542

ADDITIVITY OF BIOASSAY RESULTS IN WATER SAMPLES OF UNKNOWN COMPOSITION (DIE ADDITIVITAET DER RESULTATE VON BIOTESTS MIT WAESSERN UNBEKANNTER ZUSAMMENSETZUNG).
Ruhrverband, Essen (Germany, F.R.). Chemisches und Biologisches Lab.
For primary bibliographic entry see Field 5A.
W91-07543

DETERMINATION OF ADAPTATION OF THE ACTIVATED SLUDGE FOR INDUSTRIAL WASTEWATER.
Kemijski Inst. Boris Kidric, Ljubljana (Yugoslavia).
For primary bibliographic entry see Field 5D.
W91-07544

MEASURING COMPOST SUBSTRATE DEGRADABILITY.
Los Angeles City Solids Technology Div., CA.
For primary bibliographic entry see Field 5D.
W91-07559

KRIGING TECHNIQUE FOR RIVER FLOOD REPRESENTATION (LE KRIGEAGE DUAL, UNE TECHNIQUE POUR LA CARTOGRAPHIE AUTOMATISEE DES ZONES D'INONDATION).
Ecole Polytechnique, Montreal (Quebec). Groupe de Recherche CASTORPLUS.
C. Marche, G. Lessard, and B. El Gharbi.
Journal of Hydraulic Research JHYRAF, Vol. 28, No. 5, p 629-643, 1990. 9 fig, 10 ref. English summary.

Descriptors: *Dam failure, *Flood forecasting, *Geostatistics, *Hydraulic engineering, *Kriging, *Water surface profiles, Flood plain management, Forecasting, Hydrologic maps, Mathematical equations, Model studies, Quebec.

The kriging technique is a geostatistical estimation method which can be used to interpolate the value of a given property based on the value of the same properties at various experimental points. The solution of this system is a set of coefficients that can then be used to interpolate the function at any given point by a simple scalar product with the covariance of each sample point. In a civil engineering project, the natural ground surface is generally described by a set of data from various sources and precision such as contour lines digitized from existing maps, bathymetric cross sections, or surveys. For design purposes, these points may be replaced by a mathematical function representing the ground surface. It is then very easy to represent a cross section, calculate a volume relative to another surface, calculate the intersection of two surfaces or generate the contour lines incorporating all the available data. The relative precision of the input data points may be taken into account through the nugget effect. If it is zero at a given point, the surface will go through this point. This method was used to represent the ground surface of a rural area on the north shore of Lac St. Jean, Quebec, Canada. The purpose of the study was to simulate the flooding process resulting from the failure of an upstream dam. The water profile along the valley at variant time steps was obtained using the NWS Dambreak Flood Forecasting Model, and then extended laterally to obtain a water surface also represented by its mathematical equation. The evolution of the flooded area at various times after failure corresponds to the intersection of the ground with the various water surfaces. The intersection of two surfaces is easily determined by substraiting their corresponding elevation on a regular grid and evaluating the contour at elevation zero. (Author's abstract)
W91-07603

MEASUREMENT OF ATMOSPHERIC WATER VAPOR: RADIOMETER COMPARISON AND SPATIAL VARIATIONS.
Cooperative Inst. for Research in Environmental Science, Boulder, CO.
For primary bibliographic entry see Field 2B.
W91-07614

HIGH RESOLUTION AEROMAGNETIC SURVEY OF LAKE SUPERIOR.
Geological Survey of Canada, Ottawa (Ontario).
For primary bibliographic entry see Field 8E.
W91-07615

VARIATION IN RAINFALL CATCH FROM STANDARD UK METEOROLOGICAL OFFICE RAINGAUGES: A TWELVE YEAR CASE STUDY.
Liverpool Univ. (England). Dept. of Geography.
C. I. Essery, and D. N. Wilcox.
Hydrological Sciences Journal HSJODN, Vol. 36, No. 1, p 23-34, February 1991. 4 fig, 1 tab, 20 ref.

Descriptors: *Areal precipitation, *Error analysis, *Measuring instruments, *Meteorological data collection, *Meteorology, *Rain gages, Case studies, Catchment areas, Ireland, Local precipitation, Nigeria, Regression analysis.

Precipitation is probably the most frequently measured component of the hydrological cycle and has a long record dating back to the seventeenth century within the United Kingdom. However, several sources of error exist in the estimation of precipitation. One source of error concerns the relationship between the precipitation collected by the rain gage and that which actually falls on the ground surface. In order to study this source of error, rainfall catches from three standard MKII Meteorological Office gages in northern Ireland were examined. These gages differ in that one is exposed, one is surrounded by a turf wall, and the third is mounted at ground level. Rainfall records between 1976 and 1988 were analyzed to assess the variations in rainfall catch between the three types of gages. During the early period of study, differences between gages exceeded those in later years, and this has been attributed to the settling-in of the new turf wall and ground level collector surfaces. After this initial period the annual differences in catch relative to the standard exposed gage were 2% and 5% for the turf wall and ground level gages, respectively. Regression analysis has produced correction equations which can convert standard exposed gage data to either turf wall or ground level equivalents. The equation for ground level/exposed gages was found to be very similar to one developed in Nigeria and has been found to be applicable to water balance studies elsewhere. (Author's abstract)
W91-07625

MULTILABORATORY EVALUATION OF METHODS FOR DETECTING ENTERIC VIRUSES IN SOILS.
Environmental Protection Agency, Cincinnati, OH.
C. J. Hurst, S. A. Schaub, M. D. Sobsey, S. R. Farrah, and C. P. Gerba.
Applied and Environmental Microbiology AEMIDF, Vol. 57, No. 1, p 395-401, February 1991, 1 fig, 4 tab, 10 ref.

Descriptors: *Analytical methods, *Enteroviruses, *Pollutant identification, *Soil analysis, *Testing procedures, *Viruses, Biological studies, Clay loam, Comparison studies, Culturing techniques, Loam, Muck soils, Quality control, Sandy soils, Soil types.

Two candidate methods for the recovery and detection of viruses in soils were subjected to round robin comparative testing by members of an American Society for Testing and Materials Subcommittee Task Group. Selection of the methods, designated 'Berg' and 'Goyal', was based on results of an initial screening which indicated that both met basic criteria considered essential by the task group. Both methods utilized beef extract solutions to achieve desorption and recovery of viruses from representative soils: a fine sand soil, an organic muck, a sandy loam, and a clay loam soil. One of the two methods, Goyal, also used a secondary concentration of resulting soil eluants via low-pH organic flocculation to achieve a smaller final assay volume. Evaluation of the two methods was simultaneously performed in replicate by nine different laboratories. Each of the produced samples was divided into portions, and these were respectively subjected to quantitative viral plaque assay by both the individual, termed independent, laboratory which had done the soil processing and a single common reference laboratory, using a single cell line and passage level. The Berg method seemed to produce slightly higher virus recovery values; however, the differences in virus assay titers for samples produced by the two methods were not statistically significant ($P <$ or equal to 0.05) for any one of the four soils. Despite this lack of a method effect, there was a statistically significant laboratory effect exhibited by assay titers from independent versus reference laboratories for two of the soils, sandy loam and clay loam. This is assumed to reflect the inexact nature of performing viral assays by means of cell culturing techniques. While all laboratories used the same cell culture line, they were allowed to select their own choice of cell culture media and use their own protocols for both cell cultivation and viral assay. These allowances may have influenced the relative sensitivity of the cultured cells to cytotoxins present in processed samples. (Doyle-PTT)
W91-07649

IMPROVED METHOD FOR COLIFORM VERIFICATION.
Lycoming Coll., Williamsport, PA. Dept. of Biology.
J. D. Diehl.
Applied and Environmental Microbiology AEMIDF, Vol. 57, No. 1, p 604-605, February 1991, 3 ref.

Descriptors: *Bacteria, *Bacterial analysis, *Bioindicators, *Coliforms, *Culturing techniques, *Pollutant identification, *Testing procedures, *Water analysis, *Water quality monitoring, Bioassay, Biological samples, Enzymes.

A method for coliform verification presented in Standard Methods for the Examination of Water and Wastewater has been modified by performing beta-galactosidase assays with isolates grown on nutrient agar prepared with and without a known inducer of the lactose operon. Coliforms are verified by assay for enzymes cytochrome oxidase and beta-galactosidase in isolates grown on nutrient agar. Isolates that are beta-galactosidase positive and oxidase negative are coliforms. Since nutrient agar does not contain inducers of the lactose operon which is responsible for beta-galactosidase production it is reasoned that some coliforms might escape verification by this method. The study indicates that 13.3% of coliforms would have escaped detection if beta-galactosidase assays had been performed on coliforms cultured on nutrient agar alone, while 100% of the isolates cultured in the presence of lac operon inducer isopropyl beta-D-thiogalactopyranoside (IPTG) tested positive for beta-galactosidase. The presence of IPTG had no detectable influence on the oxidase test. It is concluded that coliform verification is improved by the addition of IPTG to nutrient agar. (Doyle-PTT)
W91-07657

SUSPENDED SOLIDS EVALUATION OF A HIGHLY SALINE ORGANIC INDUSTRIAL WASTE.
Mississippi State Univ., Mississippi State. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W91-07706

SCIENTIFIC AND UNSCIENTIFIC IRRIGATION SCHEDULING.
Texas A and M Univ., College Station. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 3F.
W91-07803

WATER-RESOURCES DATA-NETWORK EVALUATION FOR MONTEREY COUNTY, CALIFORNIA, PHASE 3: NORTHERN SALINAS RIVER DRAINAGE BASIN.
Geological Survey, Sacramento, CA. Water Resources Div.
For primary bibliographic entry see Field 7A.
W91-07819

WELL INSTALLATION AND DOCUMENTATION, AND GROUND-WATER SAMPLING PROTOCOLS FOR THE PILOT NATIONAL WATER-QUALITY ASSESSMENT PROGRAM.
Geological Survey, Reston, VA.

For primary bibliographic entry see Field 7A.
W91-07824

BA AND SR DISTRIBUTION AT THE WATER-TABLE: IMPLICATIONS FOR MONITORING GROUND-WATER AT NUCLEAR WASTE REPOSITORY SITES.
Weizmann Inst. of Science, Rehovoth (Israel). Dept. of Isotope Research.
For primary bibliographic entry see Field 2K.
W91-07828

PORTABLE FLOWMETER FOR SEWERS THAT SURCHARGE.
For primary bibliographic entry see Field 5D.
W91-07898

REMOTE-SENSING TECHNIQUES FOR DETERMINING THE REGIONALLY VARIABLE CHARACTERISTICS OF DRAINAGE BASINS.
Institutul de Meteorologie si Hidrologie, Bucharest (Romania).
For primary bibliographic entry see Field 2E.
W91-07921

DATA ACQUISITION WITHIN A REGIONAL SCALE: THE EXPERIENCE OF THE REMOTE SATELLITE TRANSMISSION IN WEST AFRICA.
Institut Francais de Recherche Scientifique pour le Developpement en Cooperation, Abidjan (Ivory Coast). Centre ORSTOM d'Adiopodoume.
For primary bibliographic entry see Field 5G.
W91-07922

CONTRIBUTION TO RESEARCH OF EVAPOTRANSPIRATION USING REMOTELY SENSED CROP TEMPERATURE.
Ljubljana Univ. (Yugoslavia). Div. for Agricultural Water Management and Engineering.
For primary bibliographic entry see Field 2D.
W91-07923

GROUNDWATER RECHARGE THROUGH THE UNSATURATED ZONE OF SOUTHEASTERN BOTSWANA: A STUDY OF CHLORIDES AND ENVIRONMENTAL ISOTOPES.
Botswana Univ., Gaborone. Dept. of Geology.
For primary bibliographic entry see Field 2G.
W91-07925

ENVIRONMENTAL TRACER APPROACH AS A TOOL FOR HYDROLOGICAL EVALUATION AND REGIONALIZATION OF CATCHMENT SYSTEMS.
Technische Univ. Braunschweig (Germany, F.R.). Inst. fuer Geographie.
For primary bibliographic entry see Field 2E.
W91-07926

SIMPLE CHLORIDE BALANCE ROUTING METHOD TO REGIONALIZE GROUNDWATER RECHARGE: A CASE STUDY IN SEMI-ARID BOTSWANA.
Vrije Univ., Amsterdam (Netherlands). Inst. voor Aardwetenschappen.
For primary bibliographic entry see Field 2F.
W91-07929

DETECTION OF FRESH-WATER/SEA-WATER INTERFACE BY THE TIME DOMAIN ELECTROMAGNETIC (TDEM) METHOD IN ISRAEL.
Institute for Petroleum Research and Geophysics, Holon (Israel).
For primary bibliographic entry see Field 5B.
W91-07977

SALT-WATER INTRUSION MONITORING BY RESISTIVITY AND IP-TOMOGRAPHIC METHODS.
Politecnico di Torino (Italy). Dipt. di Georisorse e Territorio.
For primary bibliographic entry see Field 5B.
W91-07978

RESULTS OF AIRBORNE EM GROUNDWATER EXPLORATION IN A DESERT AREA USING THE CENTROID DEPTH ALGORITHM FOR EVALUATION.
Bundesanstalt fuer Geowissenschaften und Rohstoffe, Hanover (Germany, F.R.).
For primary bibliographic entry see Field 2F.
W91-07979

STRUCTURAL AND BEHAVIORAL CHARACTERISTICS OF A COMMERCIAL HUMIC ACID AND NATURAL DISSOLVED AQUATIC ORGANIC MATTER.
Connecticut Univ., Storrs. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2K.
W91-08018

LABORATORY DIFFUSION TESTING FOR WASTE DISPOSAL: A REVIEW.
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5E.
W91-08039

IN VITRO PROPAGATION AND BIOASSAY SYSTEMS FOR EVALUATING GROWTH REGULATOR EFFECTS ON MYRIOPHYLLUM SPECIES.
Florida Univ., Gainesville. Inst. of Food and Agricultural Sciences.
For primary bibliographic entry see Field 4A.
W91-08073

MEASUREMENT OF LIGHT ABSORPTION COEFFICIENT IN LAKE BAIKAL WATER MEDIA (IN RUSSIAN).
Irkutskii Gosudarstvennyi Univ. (USSR).
L. B. Bezrukov, N. M. Budnev, M. D. Gal'perin, Z. A. M. Dzhilkibaev, and O. Y. Lanin.
Okeanologiia OKNOAR, Vol. 30, No. 6, p 1022-1026, 1990. 4 fig, 5 ref. English summary.

Descriptors: *Lake Baikal, *Limnology, *Measuring instruments, *Optical properties, *Transparency, *USSR, Filters, Lakes, Radiation, Water depth.

The possibility of measuring the light absorption coefficient of water by using a cosinus source with a limited angle of radiation and a cosinus detector with a limit angle of view was investigated for waters of different scattering properties. The device was found to permit the measurement of light absorption coefficient in 'clear' water ($P < 0.5$) with less than 5% error. Measurements of spectral dependence and water depth as well as determination of the P parameter were made for water from Lake Baikal (USSR). (Doria-PTT)
W91-08084

INSTRUMENT FOR THE DIRECT DETERMINATION OF OXYGEN UTILISATION RATE.
Cape Town Univ. (South Africa). Dept. of Chemical Engineering.
E. W. Randall, A. Wilkinson, and G. A. Ekama.
Water SA WASADV, Vol. 17, No. 1, p 11-18, January 1991. 6 fig, 1 tab, 8 ref.

Descriptors: *Activated sludge process, *Automation, *Dissolved oxygen, *Instrumentation, *Oxygen uptake, *Wastewater analysis, *Wastewater treatment, Aerobic digestion, Biological wastewater treatment, Computer programs, Computers.

An instrument that completely automates oxygen utilization rate (OUR) determination in aerobic biological reactors was developed that is comprised of a dissolved oxygen concentration (DO) and a temperature probe; an analog module for amplifying the signal from he DO and temperature probes; a micorprocessor unit which performs the timing functions; reads the DO, temperature and time signals; and performs the data processing functions such as calculating the OUR. It controls the dissolved oxygen (DO) concentration between specified upper and lower limits with an on-off solenoid valve in the air supply line and computes with a microprocessor the OUR from the DO versus time curve during the air-off period. In addition to operating as a stand-alone DO meter or DO controller/OUR meter, it can be linked to a host computer (PC) for transfer of the accumulated OUR data for further processing or complete control of the instrument PC software. The instrument can be applied directly for automatic OUR measurement in laboratory or pilot-scale biological reactors (1) with long actual hydraulic retention times (>3 hr); (2) where mixing and aeration are independent operations; and (3) where aeration is provided by a diffused air bubble aeration system. For full-scale systems the OUR meter can be implemented only indirectly in a satelite reactor (ca 200 L) with independent mixing and diffused air bubble aeration. (Doria-PTT)
W91-08088

COMPARATIVE SEED GERMINATION TESTS USING TEN PLANT SPECIES FOR TOXICITY ASSESSMENT OF A METAL ENGRAVING EFFLUENT SAMPLE.
Illinois State Water Survey Div., Peoria. Water Quality Section.
For primary bibliographic entry see Field 5C.
W91-08123

COMPARISON OF BULK AND WET-ONLY PRECIPITATION COLLECTORS AT RURAL SITES IN THE UNITED KINGDOM.
Warren Spring Lab., Stevenage (England).
For primary bibliographic entry see Field 2B.
W91-08124

MOISTURE DISTRIBUTION IN SLUDGES.
Camp, Dresser and McKee, Inc., Raleigh, NC.
For primary bibliographic entry see Field 5D.
W91-08137

MODELS OF SEWAGE SLUDGE CONDITIONING.
Istituto di Ricerca sulle Acque, Bari (Italy).
For primary bibliographic entry see Field 5D.
W91-08140

COST-EFFECTIVENESS OF THE STREAMFLOW-GAGING PROGRAM IN MINNESOTA.
Geological Survey, St. Paul, MN. Water Resources Div.
T. A. Winterstein, and A. D. Arntson.
Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4129, 1989. 94 p, 14 fig, 11 tab, 26 ref, 2 append.

Descriptors: *Cost-benefit analysis, *Data acquisition, *Minnesota, *Network design, *Stream gaging, *Streamflow, *Water resources data, Data interpretation, Economic aspects.

A three-step analysis of the cost effectiveness of the streamflow gaging program in Minnesota is documented in this report. In the first step, the data uses and funding sources were identified for the 96 continuous-record stream-flow gaging stations operated in 1985. Nineteen sources of funding and 42 uses were identified for the data collected in this program. In the second step, multiple linear regression analysis was investigated as a possible method for providing the data collected at 23 stations. However this method was not sufficiently accurate to provide the needed data, and it is recommended that the 23 stations remain in the program. In the third step, the cost-effectiveness of collecting data from 77 of the remaining 90 stations was determined for the open-water period, April 1 through October 30. The current policy for collecting data from the 77 stations during the open water period cost $198,000 in 1985. The estimated average standard error per station for the statewide network could be reduced from 24.4% to 20.6% at the $198,000 budget, if the minimum number of

discharge measurements at each station was reduced from 5 to 3 during the open water period, and the remaining budget was used to make additional discharge measurements at stations with large standard errors. It is recommended that before this data collection plan is implemented, the effects of the plan on the cost of collecting data be evaluated for: (1) possible increased lost records because of the data collection plan, and (2) the possible need for additional trips to visit noncontinuous-record stations. It is also recommended that the data-accuracy needs of the funding agencies be considered before the plan is implemented. (Lantz-PTT)
W91-08185

DATA COLLECTION PROGRAM FOR PAMLICO RIVER ESTUARY MODEL CALIBRATION AND VALIDATION.
Geological Survey, Raleigh, NC. Water Resources Div.
J. D. Bales.
IN: Estuarine and Coastal Modeling. Proceedings of a Conference held November 15-17, 1989, Newport, Rhode Island. American Society of Civil Engineers, New York. (1989) p 492-501, 5 fig, 1 tab, 10 ref.

Descriptors: *Data acquisition, *Estuaries, *Model studies, *Network design, *North Carolina, *Pamlico River, Flow pattern, Flow velocity, Hydraulic models, Hydrodynamics, Mathematical models, Saline-freshwater interfaces, Salinity, Water quality.

An investigation was conducted to collect and interpret continuous records relating to the flow characteristics of the Pamlico Estuary, North Carolina, and to calibrate and validate a numerical model of estuarine hydrodynamics. The study reach is 50 km long and ranges in width from 330 meters at the upstream boundary to 6.4 km at the downstream end. Water levels were recorded at 6 locations along the estuary; daily water level range is typically greater at the head of the estuary than at the mouth, most likely due to upstream narrowing of the channel. Water quality data were recorded at 14 locations, and indicate that saline waters with low dissolved oxygen concentrations move upstream along the bottom of the estuary. Point velocities were monitored for 3 weeks at 7 locations; vertical profiles of horizontal velocity were made at the boundaries of the study reach for about 32 hours. Local tributary inflows and wind speed and direction are also being determined. These data, when complete, will be used to calibrate the estuarine flow model. (Author's abstract)
W91-08186

OPERATION OF HYDRAULIC DATA-COLLECTION STATIONS BY THE U.S. GEOLOGICAL SURVEY IN 1989.
A. C. de la Torre.
Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Open File Report 90-171, (1990). 52 p, 43 fig, 1 tab, 7 ref.

Descriptors: *Data acquisition, *Data collections, *Geological surveys, *Groundwater data, *Hydrologic data collections, *Surface water, *Water quality, *Water resources data, Economic aspects, Flow discharge, Groundwater level, Networks, Precipitation, Reservoirs, Satellite technology, Streams, Telemetry.

The US Geological Survey (USGS) operates hydrologic data collection stations nationwide to serve the needs of all levels of government, the private sector, and the general public for water resources information. During fiscal year 1989, surface water discharge was determined at 10,665 stations; stage data on streams, reservoirs, and lakes were recorded at 2,062 stations, and various surface water quality characteristics were determined at 3,650 stations. In addition, groundwater levels were measured at 34,682 stations, and the quality of groundwater was determined at 8,823 stations. Data on sediment were collected daily at 172 stations and on a periodic basis at 1019 stations. Information on precipitation quantity was collected at 1,235 stations and the quality of precipitation was analyzed at 72 stations. Data collection platforms for satellite telemetry of hydrologic information were used at 2,742 USGS stations. Funding for the hydrologic stations was derived, either solely or in combination, from 3 major sources: the Geological Survey's Federal Program appropriation, the Federal State cooperative Program, and reimbursements from other Federal agencies. The number of hydrologic stations operated by the Geological Survey declined in some categories and increased in others from fiscal year 1983 to 1989. Although the number of continuous record surface water discharge stations increased by 87, the total number of surface water discharge stations was reduced by 411 stations; surface water quality stations declined by 176 stations; groundwater level stations increased by 1,043 stations; and groundwater quality stations increased by 1,175 stations. (Author's abstract)
W91-08188

AQUATIC TOXICITY TESTING.
Eckenfelder, Inc., Nashville, TN.
For primary bibliographic entry see Field 5A.
W91-08193

7C. Evaluation, Processing and Publication

UTILITY OF EMPLOYING MATHEMATICAL MODELS IN REGULATING GROUNDWATER PROTECTION.
For primary bibliographic entry see Field 5G.
W91-07170

EVALUATING GROUNDWATER REMEDIATION WITH GROUNDWATER MODELING.
Dunn Geoscience Corp., Albany, NY.
For primary bibliographic entry see Field 5G.
W91-07171

NEW METHOD TO MODEL TRANSPORT AND FATE OF GASOLINE FROM LEAKING UNDERGROUND STORAGE TANKS.
New Jersey Inst. of Tech., Newark. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 5B.
W91-07179

POTENTIOMETRIC SURFACE OF THE KINGSHILL AQUIFER AND HYDROLOGIC CONDITIONS: ST. CROIX, U.S. VIRGIN ISLANDS, JULY 1987.
Geological Survey, San Juan, PR. Water Resources Div.
For primary bibliographic entry see Field 2F.
W91-07198

CE-QUAL-RIV1: A DYNAMIC, ONE-DIMENSIONAL (LONGITUDINAL) WATER QUALITY MODEL FOR STREAMS. USER'S MANUAL.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
For primary bibliographic entry see Field 5B.
W91-07200

NATIONAL WATER INFORMATION SYSTEM USER'S MANUAL. VOLUME 2, CHAPTER 2. WATER-QUALITY SYSTEM.
Geological Survey, Reston, VA.
D. V. Maddy, L. E. Lopp, D. L. Jackson, R. H. Coupe, and T. L. Schertz.
Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Open File Report 89-617, (1989). 218p, 11 fig, 4 append.

Descriptors: *Data storage and retrieval, *Handbooks, *Information systems, *National Water Information System, *Water quality, Computers, Databases, Information retrieval.

The Water-Quality System is a water quality data storage and retrieval system that is part of the National Water Information System developed by the US Geological Survey's (USGS) Water Resources Division. The National Water Information System is a distributed water database in which data can be processed over a network of minicomputers at USGS offices throughout the United States. This system comprises the Automated Data Processing System, the Ground-Water Site Inventory System, the Water-Quality System, and the Water-Use Data System. The Water-Quality System provides for entering new sites, updating existing sites within the local database, and updating the Water Data Storage and Retrieval System (WATSTORE), which is the national database. In addition, the Water-Quality System provides for retrieving and displaying water quality data stored in the local database. This manual contains instructions for users of the Water-Quality System and discusses the general operating procedures for the programs found within the system. (Author's abstract)
W91-07202

DREDGING ALTERNATIVE STUDY, CUBITS GAP, LOWER MISSISSIPPI RIVER. REPORT 1: TABS-1 NUMERICAL MODEL INVESTIGATION.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
For primary bibliographic entry see Field 8B.
W91-07212

DREDGING ALTERNATIVES STUDY, CUBITS GAP, LOWER MISSISSIPPI RIVER. REPORT 2: TABS-2 NUMERICAL MODEL INVESTIGATION.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
H. J. Lin, W. D. Martin, and D. R. Richards.
Available from the National Technical Information Service, Springfield, VA 22161 as AD-A231 238. Price codes: A04 in paper copy, A01 in microfiche. Technical Report HL-90-20, November 1990. Report 2 of a Series. Volume I: Main Text and Appendix A. 56 p, 31 fig, 2 tab, 8 ref.

Descriptors: *Cubits Gap, *Dredging, *Mathematical models, *Mississippi River, *Model studies, *TABS-1 Model, Hydrographs, Sediment transport, Sedimentation.

The results are presented of a numerical model investigation whose primary objective was to determine the best method to control shoaling in the navigation channel between Cubits Gap and Head of Passes. The secondary objective was to evaluate the best design configuration for a structural dike plan located at Cubits Gap and the ability of these designs to return the flow distribution to its historical levels. This investigation used the TABS-2 finite element numerical model RMA-2V for hydrodynamic analysis and STUDH for sediment transport computation. A large-flow 87-day hydrograph was used to determine the performance of each plan. Results from the sedimentation modeling showed that the best nonstructural plan was advanced maintenance. It provided a smaller quantity of shoaling than the sediment trap plan and affected a smaller area of the navigation channel. Both nonstructural plans, however, would increase the channel shoaling rate compared to existing conditions. For the structural plan, Plan 1 with a 2,800 ft long angle dike and 800 ft-long headland dike provided the least amount of shoaling of any plan tested. All three dike plans tested would result in a substantial reduction in channel shoaling. Results from the hydrodynamic modeling showed that dike plan 1 returned the flow distribution at Cubits Gap to the amount expected with the supplement II works in place. This study did not address long-term sedimentation effects within Cubits Gap. If one of the structural plans is selected for implementation, a detailed study in the vicinity of Cubits Gap is recommended to optimize the performance of the structure. (Lantz-PTT)
W91-07216

ESTIMATING NET RECHARGE TO THE WATER TABLE IN THE GIRGARRE PROJECT

AREA USING HISTORIC PIEZOMETRIC DATA AND LINEAR PROGRAMMING.
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
For primary bibliographic entry see Field 2F.
W91-07222

MAJOR GEOHYDROLOGIC UNITS IN AND ADJACENT TO THE OZARK PLATEAUS PROVINCE, MISSOURI, ARKANSAS, KANSAS, AND OKLAHOMA--ST. FRANCOIS CONFINING UNIT.
Geological Survey, Rolla, MO. Water Resources Div.
For primary bibliographic entry see Field 2F.
W91-07236

REGIONAL AND LOCAL TENSOR COMPONENTS OF A FRACTURED CARBONATE AQUIFER.
Geological Survey, Doraville, GA. Water Resources Div.
For primary bibliographic entry see Field 2F.
W91-07241

SUBSURFACE SCIENCE PROGRAM: PROGRAM OVERVIEW AND RESEARCH ABSTRACTS, FY 1989-FY 1990.
Department of Energy, Washington, DC. Office of Energy Research.
Available from the National Technical Information Service, Springfield, VA. 22161 as DE90010321. Price codes: A08 in paper copy, A01 in microfiche. Report No. DOE/ER 0432, May 1990. 150p.

Descriptors: *Geochemistry, *Geohydrology, *Groundwater quality, *Research priorities, Biodegradation, Groundwater movement, Microbiological studies, Model studies, Path of pollutants.

The Office of Health and Environmental Research (OHER) within the Department of Energy's (DOEs) Office of Energy Research conducts long-term fundamental research in the physical, chemical, and biological sciences. The OHER Subsurface Science Program has a 5-yr record of fundamental research that can be applied to DOE site restoration problems. Long-term, fundamental research in subsurface science is critical to ensuring that new concepts for predicting environmental risk and facilitating cleanup are available in the future. The Subsurface Science Program is DOE's primary basic research program concerned with subsoils and groundwater, i.e., the environments that are most significantly affected by past DOE waste disposal practices. A substantial amount of research has been conducted concerning geohydrology, subsurface microbiology, and the geochemistry of chemical mixtures in the subsurface environment. This document describes the core areas for fundamental research that have been identified thus far for priority research attention within the Subsurface Science Program. The fundamental research supported in each of these high-priority scientific areas (or subprograms) is such that substantial resources have been concentrated on them for 3 to 5 years to ensure that scientific progress can be made. This research includes: cocontaminant chemistry; geochemical transport processes/colloids; multiphase fluid flow; biodegradation/microbial physiology; deep microbiology; coupled processes; and multicomponent predictive models/expert systems. Although predicting the outcome of basic research (or guaranteeing results in fixed time frames) is very difficult, selected goals for each subprogram that have been identified in consultation with investigators and the scientific community are included in this document. These goals serve as milestones against which research progress can be roughly measured. (Lantz-PTT)
W91-07247

MAJOR GEOHYDROLOGIC UNITS IN AND ADJACENT TO THE OZARK PLATEAUS PROVINCE, MISSOURI, ARKANSAS, KANSAS, AND OKLAHOMA--OZARK CONFINING UNIT.
For primary bibliographic entry see Field 2F.
W91-07252

MODELCARE 90: CALIBRATION AND RELIABILITY IN GROUNDWATER MODELLING.
For primary bibliographic entry see Field 2F.
W91-07253

PARAMETER ESTIMATION FOR THE 'VENLOER SCHOLLE' MULTI-AQUIFER SYSTEM USING SUPERCOMPUTERS.
Technische Hochschule Aachen (Germany, F.R.). Inst. fuer Wasserbau.
For primary bibliographic entry see Field 2F.
W91-07254

OPTIMUM SELECTION OF BASIS FUNCTIONS FOR ILL-POSED INVERSE PROBLEMS.
Australian National Univ., Canberra. Centre for Resource and Environmental Studies.
For primary bibliographic entry see Field 2F.
W91-07255

TEMPORAL AND SPATIAL VARIABILITY OF HYDRAULIC HEADS IN FINITE HETEROGENEOUS AQUIFERS: NUMERICAL MODELLING.
California Univ., Davis. Dept. of Land, Air and Water Resources.
For primary bibliographic entry see Field 2F.
W91-07256

CALIBRATION OF GROUNDWATER FLOW MODELS USING MONTE CARLO SIMULATIONS AND GEOSTATISTICS.
Calvin Coll., Grand Rapids, MI.
For primary bibliographic entry see Field 2F.
W91-07257

CALIBRATION AND RELIABILITY OF AN AQUIFER SYSTEM MODEL USING GENERALIZED SENSITIVITY ANALYSIS.
Australian National Univ., Canberra. Centre for Resource and Environmental Studies.
A. J. Jakeman, F. Ghassemi, C. R. Dietrich, T. J. Musgrove, and P. J. Whitehead.
IN: ModelCARE 90: Calibration and Reliability in Groundwater Modelling. IAHS Publication No. 195. International Association of Hydrological Sciences, Washington, DC. 1990. p 43-51. 3 fig, 3 tab, 8 ref.

Descriptors: *Aquifer systems, *Calibrations, *Hydrologic models, *Model studies, *Model testing, *Sensitivity analysis, Aquifer characteristics, Aquifers, Australia, Computer models, Computers, Groundwater movement, Mathematical analysis, Mathematical studies, Monte Carlo method, Statistical analysis, Transmissivity, Uncertainty.

Generalized sensitivity analysis has been used mainly to identify important processes and parameters within some hypothesized model structure. The technique employs a binary classification of parameter values on the basis of Monte Carlo simulations that yield either acceptable or unacceptable model outputs. Statistical analysis of both classes provides a relative ranking of parameter sensitivity and their covariation. The current study explores the capacity of generalized sensitivity analysis (GSA) to calibrate models of aquifer systems and quantify their reliability. The technique is illustrated for estimating the transmissivities of a steady state model of a confined aquifer in Mildura, Australia. The results compare well with a previous trial-and-error method calibration of this aquifer. In addition to providing a quantification of parametric and predictive uncertainty, the generalized sensitivity analysis technique has several other advantages. Its main disadvantage is that model runs must be performed sufficiently fast to permit an adequate number of simulations. (See also W91-07253) (Author's abstract)
W91-07258

PARAMETER ESTIMATION FROM ARTIFICIAL TRACER EXPERIMENTS.
Gesellschaft fuer Strahlen- und Umweltforschung m.b.H. Muenchen, Neuherberg (Germany, F.R.). Inst. fuer Hydrologie.
For primary bibliographic entry see Field 2F.
W91-07259

EVALUATION OF SINGLE BOREHOLE HYDROTESTS IN FREQUENCY DOMAIN BY A UNIVARIATE STATISTICAL METHOD.
Stuttgart Univ. (Germany, F.R.). Inst. fuer Wasserbau.
For primary bibliographic entry see Field 2F.
W91-07260

QUICK AND STABLE ALGORITHM FOR GROUNDWATER FLOW PARAMETER ESTIMATION UNDER UNCERTAINTY.
Karlsruhe Univ. (Germany, F.R.). Inst. fuer Hydromechanik.
For primary bibliographic entry see Field 2F.
W91-07261

APPLICATION OF AN AUTOMATIC CALIBRATION TECHNIQUE TO MODELLING AN ALLUVIAL AQUIFER.
Universidad Politecnica de Cataluna, Barcelona (Spain). Escuela Tecnica Superior de Ingenieros de Caminos, Canales y Puertos.
For primary bibliographic entry see Field 2F.
W91-07262

RELIABILITY THEORY AS APPLIED TO ESTIMATION IN CONVERGING VERSUS NONCONVERGING FLOW FIELDS.
Notre Dame Univ., IN. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2F.
W91-07263

IMPROVEMENT OF MODEL PARAMETER IDENTIFICATION IN NUMERICAL COMPUTATION.
Nanjing Univ. (China). Dept. of Earth Sciences.
For primary bibliographic entry see Field 2F.
W91-07264

LINKING GROUNDWATER HYDRAULICS AND OPTIMIZATION IN A SELF-CALIBRATING FINITE DIFFERENCE MODEL.
K.N. Toossi Univ. of Technology, Tehran (Iran). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2F.
W91-07265

MARCHAL: A THREE-DIMENSIONAL MODEL FOR GROUNDWATER FLOW AND QUALITY MODELLING.
Strasbourg-1 Univ. (France). Inst. de Mechanique des Fluides.
For primary bibliographic entry see Field 2B.
W91-07266

NUMERICAL METHOD FOR AQUIFER PARAMETER ESTIMATION UTILIZING ENVIRONMENTAL TRACERS IN A TRANSIENT FLOW SYSTEM.
Ben-Gurion Univ. of the Negev, Sde Boker (Israel). Jacob Blaustein Inst. for Desert Research.
For primary bibliographic entry see Field 2F.
W91-07267

ESTIMATION OF TRANSVERSE DISPERSIVITY IN THE MIXING ZONE OF FRESH-SALT GROUNDWATER.
Kyushu Univ., Fukuoka (Japan). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2F.
W91-07268

SIMULTANEOUS CALIBRATION OF FLOW AND TRANSPORT MODELS AND OPTIMIZATION OF REMEDIATION MEASURES.
Ecole Nationale des Ingenieurs des Travaux Ruraux et des Techniques Sanitaires, Strasbourg (France).
For primary bibliographic entry see Field 2F.
W91-07269

JOINT KRIGING AND ZONATION APPROACH TO INVERSE GROUNDWATER MODELLING.
Technical Univ. of Denmark, Lyngby.
For primary bibliographic entry see Field 2F.
W91-07270

INVERSE MODELLING OF COUPLED FLOW AND SOLUTE TRANSPORT PROBLEMS.
Universidad Politecnica de Cataluna, Barcelona (Spain). Escuela Tecnica Superior de Ingenieros de Caminos, Canales y Puertos.
For primary bibliographic entry see Field 2F.
W91-07271

USE OF AN AUTOCALIBRATION TO EVALUATE THE CONSISTENCY OF A DATA-SET IN RELATION TO GEOCHEMICAL MODEL FORMULATIONS.
Waterloopkundig Lab. te Delft (Netherlands).
For primary bibliographic entry see Field 2F.
W91-07272

PERCOLATION AND RANDOM WALK MODELS FOR SIMULATING DISPERSION PHENOMENA IN FRACTURE NETWORKS.
Ministry of Agriculture, Tel-Aviv (Israel). Water Commission.
For primary bibliographic entry see Field 5B.
W91-07273

PREDICTION OF CADMIUM ACCUMULATION IN A HETEROGENEOUS SOIL USING A SCALED SORPTION MODEL.
Agricultural Univ., Wageningen (Netherlands). Dept. of Soil Science and Plant Nutrition.
For primary bibliographic entry see Field 5B.
W91-07274

APPROACH TO MODEL TRANSPORT OF CONTAMINANTS INCLUDING GEOCHEMICAL PROCESSES: DEPENDENCE OF SORPTION COEFFICIENTS ON GEOCHEMICAL SURROUNDING.
Technische Univ. Berlin (Germany, F.R.). Inst. fuer Wassergefaehrdende Stoffe.
For primary bibliographic entry see Field 5B.
W91-07275

APPROACH TO PROCESS IDENTIFICATION: APPLICATION TO SOLUTE TRANSPORT THROUGH CLAYS.
Universidad Politecnica de Cataluna, Barcelona (Spain). Escuela Tecnica Superior de Ingenieros de Caminos, Canales y Puertos.
For primary bibliographic entry see Field 2G.
W91-07276

EXPERIMENTAL STUDY OF COUPLED FLOW AND MASS TRANSPORT: A MODEL VALIDATION EXERCISE.
Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands).
For primary bibliographic entry see Field 5B.
W91-07277

EFFECTIVE HYDRAULIC CONDUCTIVITY FOR FRACTURED MEDIA.
Royal Inst. of Tech., Stockholm (Sweden). Dept. of Land and Water Resources.
For primary bibliographic entry see Field 2F.
W91-07278

TRANSPORT AND STORAGE PHENOMENA IN A FRACTURE MATRIX SYSTEM: EXPERIMENTAL INVESTIGATIONS AND NUMERICAL MODELLING.
Hanover Univ. (Germany, F.R.). Inst. fuer Wasserwirtschaft, Hydrologie und Landwirtschaftlichen Wasserbau.
For primary bibliographic entry see Field 2F.
W91-07279

QUALITY ASSURANCE IN THE DEVELOPMENT AND APPLICATION OF GROUNDWATER MODELS.
Butler Univ., Indianapolis, IN. Holcomb Research Inst.
For primary bibliographic entry see Field 2F.
W91-07280

SETTING CALIBRATION TARGETS AND ASSESSING MODEL CALIBRATION-ROOM FOR IMPROVEMENT: AN EXAMPLE FROM NORTH AMERICA.
Montana Univ., Missoula. Dept. of Geology.
For primary bibliographic entry see Field 2F.
W91-07281

CALIBRATION OF GROUNDWATER MODELS FOR THE GRIMSEL UNDERGROUND ROCK LABORATORY, SWITZERLAND.
Colenco Ltd., Baden (Switzerland).
For primary bibliographic entry see Field 2F.
W91-07282

REDUCING GROUNDWATER FLOW MODEL UNCERTAINTIES AT YUCCA MOUNTAIN.
Weston (Roy F.), Inc., Washington, DC.
For primary bibliographic entry see Field 2F.
W91-07283

RELIABILITY OF A GROUNDWATER MODEL: THE HISTORY OF MODELLING THE JWANENG NORTHERN WELLFIELD IN BOTSWANA.
Anglo American Corp. of South Africa Ltd., Marshalltown.
For primary bibliographic entry see Field 2F.
W91-07284

MODEL CALIBRATION AND SIMULATION OF FLOW IN A HETEROGENEOUS SOIL.
HydroGeoLogic, Inc., Herndon, VA.
J. B. Kool, P. S. Huyakorn, and P. J. Wierenga.
IN: ModelCARE 90: Calibration and Reliability in Groundwater Modelling. IAHS Publication No. 195. International Association of Hydrological Sciences, Washington, DC. 1990. p 321-330. 4 fig, 2 tab, 13 ref. U. S. Nuclear Regulatory Commission Contract No. NRC-04-89-090.

Descriptors: *Calibrations, *Model studies, *New Mexico, *Simulation, *Soil properties, *Soil water, *Unsaturated flow, Anisotropy, Case studies, Data acquisition, Data interpretation, Field tests, Flow characteristics, Flow equations, Flow models, Heterogeneity, Hydraulic conductivity, Prediction, Spatial distribution, Statistical analysis, Stochastic hydrology, Stochastic models, Stochastic process.

For the last several years the U. S. Nuclear Regulatory Commission (NRC) has conducted a field experiment at the Las Cruces trench site to study water and chemical movement through an initially dry, spatially variable soil. A transient flow experiment was simulated using the classical Richard's equation with different approaches for model calibration. The results of the investigation revealed that soil heterogeneity exerted a strong influence on transient water movement and induced three-dimensional flow even in a carefully controlled experiment. A key feature of the experiment was the apparent soil anisotropy exhibited by observed moisture movement. It was shown that local soil heterogeneity could produce the observed behavior. The study revealed that the use of literature-derived model calibration parameters was likely to result in inaccurate predictions. However, good predictions were obtained when averaged hydraulic parameters were employed, especially when saturated conductivity was allowed to be anisotropic. Predictive formulas for the effective hydraulic conductivity anisotropy could be obtained from existing stochastic flow theories. However, use of these equations still required statistical characterization of site spatial variability. For the Las Cruces trench site, the stochastic theory also significantly overpredicted the degree of anisotropy. This observation suggests that the range of validity of existing stochastic unsaturated flow theories needs further evaluation. (See also W91-07253) (Korn-PTT)
W91-07285

VAPOUR TRANSPORT OF ORGANIC COMPOUNDS: SIMULATION OF FIELD EXPERIMENTS AND MODEL VALIDATION.
Waterloo Univ. (Ontario). Inst. for Ground Water Research.
For primary bibliographic entry see Field 5B.
W91-07286

PERSPECTIVE ON NON-UNIQUENESS IN THREE-DIMENSIONAL TRANSPORT SIMULATIONS OF BIODEGRADING ORGANIC CONTAMINANTS.
Waterloo Univ. (Ontario). Inst. for Ground Water Research.
For primary bibliographic entry see Field 5B.
W91-07287

DELINEATION OF GROUNDWATER PROTECTION ZONES USING FORCED GRADIENT TRACER TESTS: A MODEL VALIDATION CASE STUDY.
Stuttgart Univ. (Germany, F.R.). Inst. fuer Wasserbau.
For primary bibliographic entry see Field 2F.
W91-07288

MODEL UNCERTAINTIES IN THE SIMULATION OF RIVER MARECCHIA ALLUVIAL FAN (NORTHERN ITALY).
Bologna Univ. (Italy). Ist. di Costruzioni Idrauliche.
For primary bibliographic entry see Field 2F.
W91-07289

MODELLING HEAT TRANSFER NEAR A DEEP UNDERGROUND NUCLEAR WASTE REPOSITORY: A DISCUSSION OF BOUNDARY CONDITIONS.
Agence Nationale pour la Gestion des Dechets Radioactifs, Fontenay-aux-Roses (France).
For primary bibliographic entry see Field 5E.
W91-07290

MODELLING SOIL MOISTURE MOVEMENT FOLLOWING DRIP IRRIGATION OF SUGAR CANE.
Institute of Hydrology, Wallingford (England).
For primary bibliographic entry see Field 3F.
W91-07291

VELOCITY PREDICTION ERRORS RELATED TO FLOW MODEL CALIBRATION UNCERTAINTY.
Geraghty and Miller, Inc., Reston, VA.
For primary bibliographic entry see Field 2F.
W91-07292

SIMULATION OF BLOCK PERMEABILITIES CONDITIONED UPON DATA MEASURED AT A DIFFERENT SCALE.
Stanford Univ., CA. Dept. of Applied Earth Sciences.
For primary bibliographic entry see Field 2F.
W91-07293

REEVALUATION OF LARGE-SCALE DISPERSIVITIES FOR A WASTE CHLORIDE PLUME: EFFECTS OF TRANSIENT FLOW.
Geological Survey, Reston, VA.

For primary bibliographic entry see Field 5B.
W91-07294

GEOSTATISTICAL ASSESSMENT OF NUMERICALLY SIMULATED GROUNDWATER FLOW IN THE UPPER CHICOT AQUIFER NEAR PORT ARTHUR, TEXAS.
INTERA, Inc., Austin, TX.
For primary bibliographic entry see Field 2F.
W91-07295

STOCHASTIC ASPECTS OF NONPOINT NITRATE LEACHING FROM AGRICULTURAL FIELDS.
Hohenheim Univ., Stuttgart (Germany, F.R.). Inst. fuer Bodenkunde und Standortslehre.
For primary bibliographic entry see Field 5B.
W91-07296

REGIONALIZATION OF HYDRAULIC AQUIFER PROPERTIES-OPTIMIZATION BY GEOSTATISTICAL SIMULATION TECHNIQUES.
Freie Univ. Berlin (Germany, F.R.). Inst. fuer Angewandte Geologie.
For primary bibliographic entry see Field 2F.
W91-07297

APPLICATION OF THE RELATIONSHIP BETWEEN SMALL-SCALE AND LARGE-SCALE PERMEABILITIES TO FLUID FLOW MODELLING.
Technische Hogeschool Delft (Netherlands). Dept. of Mining and Petroleum Engineering.
For primary bibliographic entry see Field 2F.
W91-07298

KALMAN FILTER APPROACH TO THE QUANTIFICATION OF THE RELIABILITY OF A GROUNDWATER MODEL.
Institute of Applied Geoscience TNO, Delft (Netherlands).
For primary bibliographic entry see Field 2F.
W91-07299

BAYESIAN ESTIMATION OF WATER LEVELS.
Orange Free State Univ., Bloemfontein (South Africa). Inst. for Groundwater Studies.
For primary bibliographic entry see Field 2F.
W91-07300

STOCHASTIC MODELLING OF SOLUTE TRANSPORT IN GROUNDWATER: APPLICATION TO A FIELD TRACER TEST.
Florida Univ., Gainesville. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 2F.
W91-07302

STOCHASTIC ANALYSIS OF UNSTEADY GROUNDWATER HEAD-FIELD IN HETEROGENEOUS REGION, BASED ON PHYSICAL PRINCIPLES.
Nagoya Univ. (Japan). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2F.
W91-07303

HOW EFFECTIVE ARE EFFECTIVE MEDIUM PROPERTIES.
INTERA, Inc., Austin, TX.
For primary bibliographic entry see Field 2G.
W91-07304

NETWORK GEOMETRY AND SPATIAL UNCERTAINTY IN GROUNDWATER SOLUTE TRANSPORT MODELLING.
Universitaet fuer Bodenkultur, Vienna (Austria). Inst. fuer Wasserwirtchaft.
For primary bibliographic entry see Field 2F.
W91-07305

MAXIMAL CAPILLARY RISE FLUX AS A FUNCTION OF HEIGHT FROM THE WATER TABLE.
New York State Coll. of Agriculture and Life Sciences, Ithaca. Dept. of Agricultural and Biological Engineering.
For primary bibliographic entry see Field 2G.
W91-07335

SIMULATING WATER MOVEMENT IN LAYERED AND GRADATIONAL SOILS USING THE KIRCHOFF TRANSFORM.
Commonwealth Scientific and Industrial Research Organization, Townsville (Australia). Div. of Soils.
For primary bibliographic entry see Field 2G.
W91-07337

STATISTICAL PARAMETERS CHARACTERIZING THE SPATIAL VARIABILITY OF SELECTED SOIL HYDRAULIC PROPERTIES.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental and Hazardous Material Studies.
K. Unlu, D. R. Nielsen, J. W. Biggar, and F. Morkoc.
Soil Science Society of America Journal SSSJD4, Vol. 54, No. 6, p 1537-1547, November/December 1990. 4 fig, 11 tab, 22 ref.

Descriptors: *Mathematical models, *Model studies, *Soil physical properties, *Soil porosity, *Soil water, *Spatial variation, *Statistical analysis, Estimating, Groundwater flow, Heterogeneity, Hydraulic conductivity, Specific capacity, Stochasticity, Unsaturated flow.

The knowledge of the statistical parameters of the variance, sigma squared, and the correlation scale, delta, characterizing the spatial structures of the log of the saturated hydraulic conductivity, lnKs, pore size distribution parameter alpha, and the specific water capacity, C, is required in stochastic modeling in order to understand the overall response of large-scale heterogeneous unsaturated flow systems. These parameters are estimated assuming second-order stationarity and an exponential semivariogram model with nugget effect. Methods of ordinary least squares, maximum likelihood, and restricted maximum likelihood (RML) are used for estimating sigma squared and delta, while methods of cross-validation (kriging) and uncorrelated residuals are used to validate the semivariogram model with estimated sigma squared and delta. The significance of the results of parameter estimation and model validation in relation to the stochastic modeling of large-scale transient unsaturated flow is demonstrated with examples involving the variance of soil pressure head, sigma-h squared and the vertical component of effective hydraulic conductivity, K11. Results show that the estimated values of sigma squared and delta are highly dependent on the estimation method. Although the majority of the estimated parameters pass the validation tests, the RML estimates of sigma squared and delta used in estimating sigma-h squared and K11 significantly reduce the prediction uncertainties. (Author's abstract)
W91-07340

ANALYTICAL EXPRESSION FOR SOIL WATER DIFFUSIVITY DERIVED FROM HORIZONTAL INFILTRATION EXPERIMENTS.
Arizona Univ., Tucson. Dept. of Soil and Water Science.
For primary bibliographic entry see Field 2G.
W91-07341

PREDICTION TECHNOLOGY FOR SOIL EROSION BY WATER: STATUS AND RESEARCH NEEDS.
Georgia Univ., Athens. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 2J.
W91-07350

MULTIVARIATE CORRELATION ANALYSIS AND ITS APPLICATION IN ENVIRONMENTAL ANALYSIS.
Friedrich-Schiller-Univ., Jena (German D.R.). Inst. fuer Anorganische und Analytische Chemie.
S. Geiss, J. Einax, and K. Danzer.
Analytica Chimica Acta ACACAM, Vol. 242, No. 1, p 5-9, January 15, 1991. 4 fig, 9 ref.

Descriptors: *Correlation analysis, *Environmental monitoring, *Heavy metals, *Multivariate analysis, *Path of pollutants, *Sampling, *Statistical methods, Atomic absorption spectrophotometry, Cadmium, Chromium, Copper, Iron, Mathematical studies, Optimization, River flow, Rivers, Solute transport, Stochastic process, Time series analysis, Zinc.

A new method for handling correlation problems is described. The multivariate auto-correlation and cross-correlation method allows the calculation of relationships between two functions including one or several variables with respect to changes in time or distance. Two applications from environmental analytical chemistry demonstrate the advantages of the method. This method can easily be used to measure transport rates of heavy metals in river water. A possible means of measuring transport rates in flowing systems is the univariate cross-correlation function. For this purpose, time series of heavy metal concentrations (Fe, Cd, Cr, Cu,and Zn), measured by graphite-furnace atomic absorption spectrometry, were compared at two points of a river 4.5 km apart. Concentration functions of the traces of metals in the river have an evident stochastic character. The multivariate cross-correlation function showed a wide maximum over a time change of 1.5 hours. Comparison with the hydrological flow rates of the investigated river gave the expected results. It is notable that a correlation analysis was possible with plausible results although there was a small communal emitter within the experimental range. Application of the multivariate method can reduce analytical costs whether for the estimation of transport rates or for sampling frequency. (Doria-PTT)
W91-07370

HYDRODYNAMIC SIMULATION OF THE UPPER ESTUARY OF THE ST. LAWRENCE RIVER (CANADA) WITH A DRYING AND WETTING FINITE ELEMENTS MODEL (SIMULATION HYDRODYNAMIC DE L'ESTUAIRE SUPERIEUR DU FLEUVE SAINT-LAURENT (CANADA) AVEC UN MODELE AUX ELEMENTS FINIS COUVRANT-DECOUVRANT).
INRS-Eau, Sainte-Foy (Quebec).
For primary bibliographic entry see Field 2L.
W91-07524

MODELLING OF SETTLING AND FLOCCULATION OF FINE SEDIMENTS IN STILL WATER.
National Water Research Inst., Burlington (Ontario). Rivers Research Branch.
For primary bibliographic entry see Field 2J.
W91-07525

HYDRAULIC MODEL ANALYSIS FOR AN ORIFICE SPILLWAY.
Manitoba Univ., Winnipeg. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8A.
W91-07526

REFLECTIONS ON THE USE OF LONG SERIES OF CLIMATOLOGICAL OBSERVATIONS AS PART OF THE STUDY CLIMATE AND ITS CHANGES (REFLEXIONS SUR L'UTILISATION DES LONGUES SERIES D'OBERVATIONS CLIMATOLOGIQUES DANS LE CADRE DE L'ETUDE DU CLIMAT ET DE SON EVOLUTION).
Electricite de France, Grenoble. Div. Technique.
For primary bibliographic entry see Field 2B.
W91-07528

MATHEMATICAL MODELING OF HYDRODYNAMICS AND MOVEMENT OF POLLUTION IN A LAGOON SYSTEM (MODELISA-

TION MATHEMATIQUE DE L'HYDRODYNAMIQUE ET DU MOVEMENT DE LA POLLUTION EN SYSTEME LAGUNAIRE).
BCEOM-Service Hydraulique, 259 Avenue de Melgueil, 34280 La Grande Motte, France.
For primary bibliographic entry see Field 5B.
W91-07529

EVOLUTION OF THREE-PEAK RAINDROP SIZE DISTRIBUTIONS IN ONE-DIMENSIONAL SHAFT MODELS: PART I. SINGLE-PULSE RAIN.
Toronto Univ. (Ontario). Dept. of Physics.
For primary bibliographic entry see Field 2B.
W91-07610

HIGH RESOLUTION AEROMAGNETIC SURVEY OF LAKE SUPERIOR.
Geological Survey of Canada, Ottawa (Ontario).
For primary bibliographic entry see Field 8E.
W91-07615

DIGITAL TERRAIN MODELLING: A REVIEW OF HYDROLOGICAL, GEOMORPHOLOGICAL, AND BIOLOGICAL APPLICATIONS.
Australian National Univ., Canberra. Centre for Resource and Environmental Studies.
I. D. Moore, R. B. Grayson, and A. R. Ladson.
Hydrological Processes HYPRE3, Vol. 5, No. 1, p 3-30, January/March 1991. 3 fig, 1 tab, 172 ref.
National Science Foundation grants SES-8912042 and SES-8912938.

Descriptors: *Digital map data, *Digital terrain models, *Geographic information systems, *Geomorphology, *Hydrologic models, *Model studies, *Terrain analysis, *Topography, Catchment areas, Data processing, Elevation, Mathematical equations, Remote sensing, Topographic mapping, Water resources management.

The topography of a catchment has a major impact on the hydrological, geomorphological, and biological processes active in the landscape. The spatial distribution of topographic attributes can often be used as an indirect measure of the spatial variability of these processes and allows them to be mapped using relatively simple techniques. Many geographic information systems are being developed that store topographic information as the primary data for analyzing water resource and biological problems. Furthermore, topography can be used to develop more physically realistic structures for hydrologic and water quality models that directly account for the impact of topography on the hydrology. Digital elevation models are the primary data used in the analysis of catchment topography. The three major methods of structuring a DEM are grid-based, triangulated irregular network-based, and contour-based. The use if grid-based DEMs for topographic applications to hydrological, geomorphological, and biological processes is recommended because they are the most commonly available form of digital elevation data, the methods of analysis are computationally efficient and simple, and this structure is compatible with remote sensing techniques and geographic information systems. DEMS can be used for delineating drainage basins and stream networks, necessary for many land and water management and planning activities. Contour-based models offer significant computational advantages because they allow the complex two and three-dimensional flow and transport equations to be reduced to a series of coupled one-dimensional equations. Future research needs to determine the appropriate scale for analyzing certain types of hydrologic, climatic, biological, and land degradation problems in the context of their correlation with terrain attributes. (Fish-PTT)
W91-07616

APPLICATIONS OF HYDROLOGIC INFORMATION AUTOMATICALLY EXTRACTED FROM DIGITAL ELEVATION MODELS.
EROS Data Center, Sioux Falls, SD.
S. K. Jenson.
Hydrological Processes HYPRE3, Vol. 5, No. 1, p 31-44, January/March 1991. 6 fig, 1 tab, 14 ref.

Descriptors: *Data processing, *Digital map data, *Geographic information systems, *Geomorphology, *Hydrologic data, *Model studies, *Morphology, *Surface water data, *Terrain analysis, Catchment areas, Elevation, Mars, Nevada, Slopes, Topography, Watersheds.

Digital elevation models (DEMs) can be used to derive a wealth of information about the morphology of a land surface. A sixty-by-forty kilometer subarea of a geochemical stream sediment study in Nevada was selected to illustrate how automated DEM techniques can be used to delineate these watersheds. The conditioning steps were performed to produce a depressionless DEM, a flow directions dataset, and a flow accumulation dataset. Rastor to vector format conversions were then performed for the watersheds, flow accumulation values, and relocated sample points. A plot of these three datasets generated the watershed composition information. The automated approach offers a practical way to analyze the large number of sample points required to produce statistically significant results. In order to compare the results of extracting slope and flow paths from DEMs of varying resolutions, automated hydrologic feature extraction and slope techniques were applied to global DEM data with a five arc-minute cell size, to the U.S. 30 arc-second DEM, and to a three arc-second resolution DEM. Slope statistics were computed by the 'mean' method which determines the slope of each cell in a DEM by fitting a plane to the elevation of its eight surrounding cells, and by the 'steepest' method which determines the slope of each cell as the slope of a line connecting it with the cell of lowest elevation of its eight neighboring cells. Increases in cell size produced lower slope values. Automated information extraction analysis was applied to a DEM of the Kasei Valles area of Mars to provide objective surface information. The automatic formation of a realistic drainage network in the valley region, compared with non-fluvial features elsewhere, supports the hypotheses that the valley was created by hydrologic processes. The automatic delineation of depressions, watersheds, and drainage networks from DEMs is a practical labor-saving device for hydrologic applications. The quality of the information that can be automatically derived, as well as the quality of slope information, is a function of both the horizontal and vertical resolution of the DEM. (Fish-PTT)
W91-07617

CONTINENTAL HYDROLOGICAL ASSESSMENT OF A NEW GRID-BASED DIGITAL ELEVATION MODEL OF AUSTRALIA.
Australian National Univ., Canberra. Centre for Resource and Environmental Studies.
M. F. Hutchinson, and T. I. Dowling.
Hydrological Processes HYPRE3, Vol. 5, No. 1, p 45-58, January/March 1991. 5 fig, 4 tab, 44 ref.

Descriptors: *Australia, *Continental hydrology, *Data processing, *Digital map data, *Geographic information systems, *Geomorphology, *Model studies, *Terrain analysis, Catchment areas, Drainage systems, Elevation, Hydrologic models, Hydrologic properties, Topography.

Digital elevation models (DEMs) are commonly perceived as providing a means for encoding the spatial distribution of hydrological processes across a landscape. A rectangular grid digital elevation model (DEM) for Australia, with a horizontal resolution of 1/40 degree of latitude and longitude (approximately 2.5 km), was recently calculated from continent-wide coverages of point elevation and stream line data using an elevation gridding technique which incorporates a drainage enforcement algorithm. An automated drainage basin analysis of this DEM is in close agreement with existing basin analyses, both for the better-surveyed coastal areas with well-defined relief, and for large areas of low relief that make up much of the interior Lake Eyre basin and the Murray-Darling basin. The analysis of the arid western plateau region differs from the currently accepted analysis but is in broad agreement with a previous analysis of paleodrainage systems based on topographic and geological information. The drainage analysis was used to calculate cumulative distributions of spatially-distributed, hydrologically-significant terrain parameters for the Murray-Darling and Derwent River basins. The adequacy of the resolution of the DEM for continental hydrological analyses was assessed by comparing drainage basin analyses and cumulative distributions of terrain parameters at resolutions of 1/40th and 1/20th degree of latitude and longitude. It was found that the coarser resolution DEM is probably sufficiently detailed for continent-wide climatic analyses which depend heavily on the distribution of elevation. The coarser resolution DEM is also capable of accurately defining at least the broadest drainage divisions. Differences in terrain parameter statistics for the two resolutions were relatively minor for the Murray-Darling Basin, which has extensive areas with low relief; however, differences were more evident for the smaller Derwent River valley which has significantly greater relief. The significances of the observed differences in continent-wide hydrological studies remains to be conclusively demonstrated. (Fish-PTT)
W91-07618

PREDICTION OF HILLSLOPE FLOW PATHS FOR DISTRIBUTED HYDROLOGICAL MODELLING USING DIGITAL TERRAIN MODELS.
Lancaster Univ. (England). Centre for Research on Environmental Systems.
P. Quinn, K. Beven, P. Chevallier, and O. Planchon.
Hydrological Processes HYPRE3, Vol. 5, No. 1, p 59-79, January/March 1991. 14 fig, 15 ref.

Descriptors: *Drainage systems, *Flow models, *Geographic information systems, *Geomorphology, *Hydrologic models, *Ivory Coast, *Model studies, *Terrain analysis, Algorithms, Catchment areas, Digital map data, Flow pattern, Slopes, Surface flow, Topography, Water table gradient.

The accuracy of the predictions of distributed hydrological models must depend in part on the proper specification of flow pathways. Some of the problems of deriving flow pathways from raster digital terrain data were examined in the context of hydrological predictions using TOPMODEL. Distributed moisture status is predicted in TOPMODEL on the basis of spatial indices that depend on flow path definition. The sensitivity of this index to flow path algorithm and grid size was examined for the case where the surface topography is a good indicator of local hydraulic gradients, as in the valley bottoms of the Booro-Borotou catchment in the savannah region of the Ivory Coast. The multiple flow method gave a more realistic pattern of accumulating area on the hillslope portion of the catchment, but the single flow direction algorithm was more suitable once the flow has entered the more permanent drainage system. A map using a grid scale of 50 m appeared realistic, although considerable detail in the patterns was lost, particularly in the definition of the smaller gully-like flow lines. A strategy was developed for the case where downslope subsurface flow pathways may deviate from those indicated by the surface topography, as in the upper slopes of the Booro-Borotou catchment. A reference level was introduced with which to compare deviations in the water table level, and to be used within the TOPMODEL structure to derive the flow directions and distribution. The revised model gave acceptable simulations of catchment discharge for a rainy season calibration period with qualitatively successful predictions of the spatial pattern of contributing areas. However, the model could not be validated against the available early and late season data. (Fish-PTT)
W91-07619

EXTRACTION OF CHANNEL NETWORKS FROM DIGITAL ELEVATION DATA.
Massachusetts Inst. of Tech., Cambridge. Dept. of Civil Engineering.
D. G. Tarboton, R. L. Bras, and I. Rodriguez-Iturbe.
Hydrological Processes HYPRE3, Vol. 5, No. 1, p 81-100, January/March 1991. 12 fig, 3 tab, 30 ref.
National Science Foundation Grant No. ECE-8513556.

Descriptors: *Data processing, *Digital map data, *Drainage density, *Drainage patterns, *Geographic information systems, *Geomorphology, *Hydrologic models, *Model studies, Channel morphology, Channels, Data interpretation, Elevation, Networks, Scale factors.

Channel networks with arbitrary drainage design or resolution can be extracted from digital elevation data. However, for digital elevation data derived networks to be useful they have to be extracted at the correct length scale or drainage density. A criterion is suggested for determining the appropriate drainage density at which to extract networks from digital elevation data. The criterion is basically to extract the highest resolution (highest drainage density) network that satisfies scaling laws that have traditionally been found to hold for channel networks. Procedures that use this criterion were tested on 21 digital elevation data sets well distributed throughout the U.S. Five pairs of data sets from the same river basin with digital elevation models (DEMs) of different pixel size were studied to determine whether the scales (drainage density) obtained were dependent on data resolution and data set size. The drainage densities obtained from the constant drop analysis agreed fairly well for all five data sets. The comparison of slope scaling drainage densities for two pairs was good. Analysis of a subbasin suggests a higher drainage density for the subbasin, possibly some indication of a data set size or scale effect. Despite the effect of errors, it was possible to detect fundamental or basic scales where the constant drop and slope-area scalings break, placing a limit on how finely the network should be resolved and suggesting a support area that should be used to extract channel networks from DEMs. The procedures proposed have justification in terms of network properties and are therefore preferable to procedures based on local curvature. The analysis of stream drops seems more robust than the analysis of slope scaling which was more susceptible to data errors. (Fish-PTT)
W91-07620

GEOGRAPHIC INFORMATION SYSTEMS AND NON-POINT SOURCE WATER QUALITY AND QUANTITY MODELLING.
Oklahoma Univ., Norman. School of Civil Engineering and Environmental Science.
B. E. Vieux.
Hydrological Processes HYPRE3, Vol. 5, No. 1, p 101-113, January/March 1991. 7 fig, 28 ref.

Descriptors: *Geographic information systems, *Geomorphology, *Hydrologic models, *Model studies, *Nonpoint pollution sources, *Terrain analysis, *Water pollution sources, Catchment areas, Computer models, Data interpretation, Data processing, Digital map data, Overland flow, Water quality management.

Water quality and quantity affected by nonpoint sources of contaminants is dependent on spatially distributed attributes of a catchment or watershed. The integration or linkage of the spatial data handling capabilities of a geographic information system (GIS) with a distributed process, hydrologic model offers the advantages associated with utilizing the full information content of the spatially distributed data to analyze the hydrologic processes. A GIS is capable of manipulating both the input and output parameters required by distributed process models. The GIS, ARC/INFO and the finite element solution were applied to the kinematic wave equations, to process the spatially variable terrain in a small watershed using a Triangular Irregular Network (TIN). The TIN facets were used to provide land surface slope in a finite element solution of overland flow which is a fundamental subprocess affecting nonpoint source, water quality and quantity. The GIS representation of model results allowed improved visualization of the hydrologic processes. The advantage of a GIS is that the model results can be combined with other map coverages to allow comparison of cause-and-effect relationships or co-occurrences (for example, the identification and location of soil series and management that may contribute to surface or subsurface contamination). The capability to satisfactorily convey the desired or intended meaning of the simulated results greatly enhances the impact on decision makers influencing nonpoint source water quality and quantity. (Fish-PTT)
W91-07621

TERRAIN ANALYSIS FOR URBAN STORMWATER MODELLING.
Texas Univ. at Austin. Dept. of Civil Engineering.
D. Djokic, and D. R. Maidment.
Hydrological Processes HYPRE3, Vol. 5, No. 1, p 115-124, January/March 1991. 3 fig, 3 tab, 19 ref. National Science Foundation Grant MSM 8717452.

Descriptors: *Geographic information systems, *Geomorphology, *Model studies, *Storm runoff, *Terrain analysis, *Urban drainage, *Urban hydrology, *Urban runoff, Design flow, Drainage systems, Inlets, North Carolina, Overland flow, Pipes.

A geographic information system (ARC/INFO) has been used to develop a model of the urban environment for storm drainage analysis. The drainage system is divided into surface terrain, stormwater intakes, and the drainage network. The intakes hydrologically connect surface and subsurface flow elements. The drainage network consists of both manmade structures (pipes and channels) and overland flow paths that connect them. The land surface terrain is defined by triangulated irregular network (TIN), which is used to determine necessary parameters for design flow calculations. Each of the three basic elements of the urban terrain representation, inlets (defined as points), drainage network (defined as lines), and surface terrain (defined as TINs), has its own specific data structure. The three databases are fully integrated, and the stored information is used to determine whether inlets and pipes can convey 10 and 25-year design flows, using the rational method. An 'intelligent network builder' is developed using the Nexpert Object expert system shell, to test for completeness of databases and flow paths prior to hydrological computations. If necessary, the intelligent network builder starts up ARC/INFO procedures that fill in missing links in the drainage network and missing flow properties of its components. An example application was made to the drainage system of a section of the City of Asheville, North Carolina. (Author's abstract)
W91-07622

LOGIC PROGRAMMING IN GROUNDWATER RESOURCES MANAGEMENT.
Bari Univ. (Italy). Ist. di Scienze dell'Informazione.
For primary bibliographic entry see Field 2F.
W91-07623

ACCOUNTING FOR THE STOCHASTIC OCCURRENCE OF LANDSLIDES WHEN PREDICTING SEDIMENT YIELDS.
Washington Univ., Seattle. Dept. of Geological Sciences.
For primary bibliographic entry see Field 2J.
W91-07725

PEAKFLOW ESTIMATION USING AN ANTECEDENT PRECIPITATION INDEX (API) MODEL IN TROPICAL ENVIRONMENTS.
Oregon State Univ., Corvallis. Agricultural Experiment Station.
R. L. Beschta.
IN: Research Needs and Applications to Reduce Erosion and Sedimentation in Tropical Steeplands. IAHS Publication No. 192. International Association of Hydrological Sciences, Washington, DC. 1990. p 128-137. 3 fig, 1 tab, 10 ref.

Descriptors: *Hawaii, *India, *Model studies, *Precipitation, *Rainfall intensity, *Rainfall-runoff relationships, *Storm runoff, *Tropical areas, Catchment areas, Estimating, Hydrographs, Mathematical models, Simulation analysis, Storms, Stream discharge, Temporal distribution.

High flows at the mouth of a catchment are primarily dependent on the occurrence of large amounts of rainfall over a relatively short period of time. An antecedent precipitation index (API) model is presented which utilizes a hydrograph recession coefficient in conjunction with precipitation amounts and timing to simulate streamflow during large storm events. The model was applied to the estimation of peakflows in the Moanalua Valley, a 865 ha watershed in Hawaii, with a 14% average absolute error rate. Simulation of stream levels of the Wainganga River in India yielded absolute errors in peak discharges averaging 0.4 m. The API model can be used to simulate storm runoff, and may have widespread application in tropical regions for discharges from large rainfall events. Additional simulations over a wide range of hydrologic conditions in tropical catchments are needed to further evaluate the potential applicability and accuracy of the API method. (See also W91-07713) (Brunone-PTT)
W91-07726

REDUCE EROSION AND SEDIMENTATION IN A TROPICAL WATERSHED WITH A SOIL EROSION SIMULATION MODEL.
Hanover Univ. (Germany, F.R.). Inst. fuer Wasserwirtschaft, Hydrologie und Landwirtschaftlichen Wasserbau.
For primary bibliographic entry see Field 2J.
W91-07728

EVALUATION OF SOIL TROPICAL EROSION AT THE CATCHMENT/BASIN SCALE.
Tennessee Univ., Knoxville. Dept. of Geography.
For primary bibliographic entry see Field 2J.
W91-07740

PREDICTING EROSION HAZARD AREAS USING DIGITAL TERRAIN ANALYSIS.
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Water and Land Resources.
For primary bibliographic entry see Field 2J.
W91-07743

USE OF CROP SIMULATION MODELS IN DRYLAND AGRICULTURE.
Texas Agricultural Experiment Station, Temple. Blackland Research Center.
For primary bibliographic entry see Field 3F.
W91-07765

POTENTIOMETRIC SURFACE OF THE ALLUVIAL AQUIFER AND HYDROLOGIC CONDITIONS NEAR CAGUAS, PUERTO RICO, MARCH 1988.
Geological Survey, San Juan, PR. Water Resources Div.
For primary bibliographic entry see Field 2F.
W91-07810

1984 FLOODING OF MALHEUR-HARNEY LAKE, HARNEY COUNTY, SOUTHEASTERN OREGON.
Geological Survey, Portland, OR. Water Resources Div.
For primary bibliographic entry see Field 2H.
W91-07811

LOW FLOWS DURING THE 1988 DROUGHT IN TENNESSEE.
Geological Survey, Nashville, TN. Water Resources Div.
For primary bibliographic entry see Field 2E.
W91-07812

GLOBAL CLIMATE TRENDS AND GREENHOUSE GAS DATA: FEDERAL ACTIVITIES IN DATA COLLECTION, ARCHIVING, AND DISSEMINATION.
Department of Energy, Washington, DC. Office of Environmental Analysis.
For primary bibliographic entry see Field 5C.
W91-07815

DATA MANAGEMENT PROGRAM PACKAGE FOR AUTOMATICALLY RECORDED WATER LEVEL DATA.
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
J. W. Smith, and G. A. Bartle.
Technical Memorandum 90/8, August 1990. 32p, 2 fig, append.

Descriptors: *Computer programs, *Data storage and retrieval, *Groundwater data, *Water level, Automation, Computers, Water resources data.

Management of automatically recorded water level data from large numbers of boreholes, requires the user to spend a lot of time and care in keeping track of all individual data files, and in organizing the final output data for analysis. This is inefficient in time and disk storage. A data management program has been designed which allows the management of all the data input files, from a group of holes, and the generation of calculated water levels, from within a single environment. The data management package consists of three executable programs; all are interactive and menu driven and require minimum learning by the user. SMAN.EXE manages the input and output of site and hole information and the water level data generated by the logging devices installed in each hole. PCAL.EXE is used to produce a water level probe calibration file which is used by SMAN when calculating the actual water levels. UPDATE.EXE creates a new site management file from an existing one, this function is used when the existing file contains up to two years of data. The programs were written and compiled using Microsoft QUICK BASIC version 4.5. (Lantz-PTT)
W91-07817

ESTIMATION OF THE RECHARGE AREA CONTRIBUTING WATER TO A PUMPED WELL IN A GLACIAL-DRIFT, RIVER-VALLEY AQUIFER.
For primary bibliographic entry see Field 2F.
W91-07820

WATER USE IN GEORGIA BY COUNTY FOR 1987.
Georgia Dept. of Natural Resources, Atlanta.
For primary bibliographic entry see Field 6D.
W91-07823

WATER RESOURCES ACTIVITIES IN MICHIGAN, 1989.
Geological Survey, Lansing, MI. Water Resources Div.
T. J. Spicer.
Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Open File Report 89-270, 1989. 78p, 11 fig, 3 tab.

Descriptors: *Data collections, *Information exchange, *Michigan, *Water resources data, *Water resources development, *Water resources research, Hydrologic data, Water resources management.

For the past 89 years, the US Geological Survey (USGS) has collected data on the water resources of Michigan. State agency cooperation in the data collection effort began in 1930, and with it began the development of a close and unique Federal-State relationship. Although early programs were largely related to the flow of streams, subsequent interest resulted in the collection of groundwater and water quality information, as well as interpretive studies of water resources locally and statewide. This report consists of four sections: (1) current projects, (2) hydrologic conditions, (3) hydrologic data stations, and (4) sources of information. The current projects section contains information concerning the status of all projects that are presently active. The section on hydrologic data stations gives locations where surface water and groundwater data are collected and the types of records available. The hydrologic conditions section provides general statewide information on water resources. The sources of information section contains a listing of publications resulting from work done by the USGS and cooperating organizations. (Lantz-PTT)
W91-07826

SIMULATION OF THE SIZE DISTRIBUTION AND EROSIVITY OF RAINDROPS AND THROUGHFALL DROPS.
Silsoe Coll. (England).
For primary bibliographic entry see Field 2B.
W91-07849

WATER-USE INFORMATION FOR THE MISSOURI RIVER BASIN.
Geological Survey, Rolla, MO. Water Resources Div.
For primary bibliographic entry see Field 6D.
W91-07902

USING SALTMOD TO PREDICT DRAINAGE AND SALINITY IN THE NILE DELTA.
International Inst. for Land Reclamation and Improvement, Wageningen (Netherlands).
R. J. Oosterbaan, and M. A. Senna.
Annual Report 1989. International Institute for Land Reclamation and Improvement, Wageningen, The Netherlands. 1989. p 63-74, 3 fig, 3 tab, 5 ref.

Descriptors: *Drainage, *Model studies, *Nile River, *SALTMOD prediction method, *Salinity, Data interpretation, Egypt, Irrigation, Simulation analysis, Surface drainage.

SALTMOD is a computation method which makes it possible to predict soil and water salinities and water table depth in agricultural land under different (geo-) hydrological conditions and varying water management scenarios. In this study, the method is applied to data from the Mashtul Pilot Area in Egypt's Nile Delta. The Pilot Area was established for drainage and salinity control in 1980 near Zagazig. It has yielded much information on water and salt balances and related factors such as irrigation and crop production. Some important factors, however, like the leaching efficiency of the soil and the natural drainage to the underlying aquifer, could not be determined. Nor were any intensive observations made of the depth of the water table or of the amount of irrigation water applied before the Pilot Area was established. SALTMOD was used to estimate the values of the unknown variables in Mashtul. Further, seasonally applied volumes of irrigation water and corresponding depths of the water table are simulated for the situation that existed before the Pilot Area was established. The method is also used to simulate the impact if alternative water management options (e.g., different drain depths) on irrigation, soil and groundwater salinity, and depth of water table. (Author's abstract)
W91-07913

REGIONALIZATION IN HYDROLOGY.
For primary bibliographic entry see Field 2A.
W91-07920

WATER AND HEAT EXCHANGE ON DIFFERENT TYPES OF LAND SURFACE ON THE NORTHERN SLOPE OF THE CENTRAL CAUCASUS.
Akademiya Nauk SSSR, Moscow. Inst. Geografii.
For primary bibliographic entry see Field 2A.
W91-07928

DISTRIBUTED MODEL DESCRIBING THE INTERACTION BETWEEN FLOOD HYDROGRAPHS AND BASIN PARAMETERS.
Graz Univ. (Austria). Inst. for Hydromechanics, Hydraulics and Hydrology.
For primary bibliographic entry see Field 2E.
W91-07930

PHYSICALLY-BASED SNOW-COVER MODEL.
National Board of Waters, Helsinki (Finland). Water Research Inst.
For primary bibliographic entry see Field 2C.
W91-07932

REGIONALIZATION IN KARST REGIONS.
Split Univ. (Yugoslavia). Faculty of Civil Engineering Sciences.
For primary bibliographic entry see Field 2F.
W91-07934

ESTIMATING FLOW CHARACTERISTICS AT UNGAUGED SITES.
Geological Survey, Reston, VA.
For primary bibliographic entry see Field 2E.
W91-07936

CANONICAL CORRELATION APPROACH TO REGIONAL FLOOD ESTIMATION.
McGill Univ., Montreal (Quebec). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W91-07937

USE OF L-MOMENTS FOR REGIONALIZING FLOW RECORDS IN THE RIO URUGUAI BASIN: A CASE STUDY.
Instituto de Pesquisas Hidraulicas, Porto Alegre (Brazil).
For primary bibliographic entry see Field 2E.
W91-07938

ESTIMATING HYDROLOGICAL PARAMETERS FROM BASIN CHARACTERISTICS FOR LARGE SEMIARID CATCHMENTS.
Hanover Univ. (Germany, F.R.). Inst. fuer Wasserwirtschaft, Hydrologie und Landwirtschaftlichen Wasserbau.
For primary bibliographic entry see Field 2E.
W91-07939

MODEL FOR FORECASTING RUNOFF FROM MOUNTAINOUS RIVERS.
Sredneaziatskii Nauchno-Issledovatel'skii Gidrometeorologicheskii Inst., Tashkent (USSR).
For primary bibliographic entry see Field 2E.
W91-07943

WEIBULL DISTRIBUTION APPLIED TO REGIONAL LOW FLOW FREQUENCY ANALYSIS.
Environment Canada, Ottawa (Ontario). Water Resources Branch.
For primary bibliographic entry see Field 2E.
W91-07944

REGIONALIZATION OF FLUVIAL SEDIMENT YIELD IN EMILIA-ROMAGNA (NORTHERN ITALY).
Bologna Univ. (Italy). Ist. di Costruzioni Idrauliche.
For primary bibliographic entry see Field 2J.
W91-07946

PROCEEDINGS OF 10TH SALT-WATER INTRUSION MEETING.
For primary bibliographic entry see Field 2F.
W91-07947

MODELLING THE SALT-WATER INTRUSION IN THE DUNE WATER-CATCHMENT AREA OF THE AMSTERDAM WATERWORKS.
Amsterdam Waterworks (Netherlands).
For primary bibliographic entry see Field 2F.
W91-07958

SOLVING VARYING DENSITY GROUNDWATER PROBLEMS WITH A SINGLE DENSITY COMPUTER PROGRAM.
Keuringsinstituut voor Waterleidingartikelen, Rijswijk (Netherlands).
For primary bibliographic entry see Field 2F.
W91-07959

MODELLING OF A COASTAL AQUIFER IN MEXICO: THE SIMULATION OF THE SALT-WATER INTERFACE MOTION.
Ecole Nationale Superieure des Mines de Paris, Fontainebleau (France). Centre d'Information Geologique.
For primary bibliographic entry see Field 2F.
W91-07962

PARTIALLY PENETRATING WELLS IN A DUPUIT TYPE FRESH/SALT FINITE-ELEMENT MODEL.
Keuringsinstituut voor Waterleidingartikelen, Rijswijk (Netherlands).
For primary bibliographic entry see Field 2F.
W91-07965

DIELECTRIC METHOD FOR PREDICTION OF POROSITY OF SATURATED SOIL.
California Univ., Davis. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2G.
W91-08081

BOUNDARY CONDITIONS FOR THE WASTE STABILIZATION POND.
Nigeria Univ., Nsukka. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W91-08116

DATA COLLECTION PROGRAM FOR PAMLICO RIVER ESTUARY MODEL CALIBRATION AND VALIDATION.
Geological Survey, Raleigh, NC. Water Resources Div.
For primary bibliographic entry see Field 7B.
W91-08186

8. ENGINEERING WORKS

8A. Structures

CASE HISTORY OF A MAJOR TURNKEY EXPANSION OF AN OPERATING INDUSTRIAL WASTEWATER TREATMENT PLANT.
Weston Services, Inc., West Chester, PA.
For primary bibliographic entry see Field 5D.
W91-07161

WATER RESOURCES DEVELOPMENT IN ASIA AND THE PACIFIC: DAM SAFETY EVALUATION AND MONITORING, WATER TARIFFS AND RAIN-WATER HARVESTING.
Economic and Social Commission for Asia and the Pacific (UN), Bangkok (Thailand).
For primary bibliographic entry see Field 6A.
W91-07192

DETERMINATIONS OF ELIGIBILITY FOR SEVEN BUREAU OF RECLAMATION DAMS IN THE PACIFIC NORTHWEST REGION: DEADWOOD DAM, GRASSY LAKE DAM, MCKAY DAM, CRANE PRAIRIE DAM, WICKIUP DAM, OWYHEE DAM, AND AGENCY VALLEY DAM.
Renewable Technologies, Inc., Butte, MT.
For primary bibliographic entry see Field 6G.
W91-07197

RIO PUERTO NUEVO FLOOD-CONTROL PROJECT, SAN JUAN, PUERTO RICO: HYDRAULIC MODEL INVESTIGATION.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
For primary bibliographic entry see Field 8B.
W91-07245

HYDRAULIC MODEL ANALYSIS FOR AN ORIFICE SPILLWAY.
Manitoba Univ., Winnipeg. Dept. of Civil Engineering.
D. H. Burn, and D. E. Lemke.
Canadian Journal of Civil Engineering CJCEB8, Vol. 17, No. 5, p 780-787, October 1990, 3 fig, 2 ref.

Descriptors: *Hydraulic design, *Hydraulic models, *Hydraulic structures, *Orifices, *Overflow channels, *Spillways, Canada, Cold regions, Electric powerplants, Flumes, Hydraulic engineering, Manitoba.

The viability of an orifice spillway for an application in the north was investigated by using hydraulic models to compare the characteristics of two spillway alternatives, an orifice spillway and a conventional overflow spillway to determine if there were any operational concerns that would prevent the consideration of an orifice spillway option. The spillways were both designed for the proposed Wuskwatim Generating Station located on the Burntwood River in northern Manitoba. Two model studies were performed, incorporating a single bay of each alternative in a flume model as well as a comprehensive site model which examined the orifice spillway option only. From an operational point of view, no complications were identified that would eliminate the orifice spillway concept for the site considered. Although none of the issues addressed presented operational difficulties of concern, other northern sides may have concerns that were not applicable to the Wuskwatim site (e.g., orifice plugging due to the release of an upstream ice jam). Site-specific investigations would be warranted. (King-PTT)
W91-07526

AQUEDUCT AT CARTHAGE (L'AQUEDUC DE CARTHAGE).
Ecole Nationale des Ingenieurs de Tunis (Tunisia).
E. Clamagirand, S. Rais, J. Chahed, R. Guefrej, and L. Smaoui.
Houille Blanche HOBLAB, Vol. 1990, No. 6, p 423-431, 1990, 7 fig, 1 tab, 11 ref. English summary.

Descriptors: *Aqueducts, *Archaeology, *Carthage, *Hydraulic structures, *Water conveyance, *Water supply, History, Hydraulic engineering, Rome, Sewer systems, Technology, Tunisia.

Recent studies and documents of the Roman era both show that the Romans had an excellent understanding of hydraulics. One approach to research into the state of Roman technology is the study of their water and sanitation systems. A hydraulic study was made of the 132-km-long Carthage Aqueduct (located in the present nation of Tunisia) which was built in 160 A.D. Using experiments, topographic relief, and observations of the terrain, it was possible to develop hypotheses which allow the formulation of longitudinal profiles, especially in the downstream part of the aqueduct. The Strickler coefficient was determined by numeric and experimental methods and, with a reconstructed longitudinal profile, used to calculate a capacity of 32,000 cu m/d (at a grade of 3%) for the aqueduct. Carthage, Rome, and Pompeii also all had highly-developed sewerage networks, which apparently were capable of handling flows comparable to those of contemporary urban centers. (King-PTT)
W91-07530

TRADITIONAL MONTANE IRRIGATION SYSTEMS IN MODERN EUROPE: AN EXAMPLE FROM VALAIS, SWITZERLAND.
Downing Coll., Cambridge (England).
For primary bibliographic entry see Field 3F.
W91-07549

PIPE PLUNGE POOL ENERGY DISSIPATOR.
Agricultural Research Service, Stillwater, OK. Water Conservation Structures Lab.
For primary bibliographic entry see Field 8B.
W91-07590

ANALYSIS OF EXISTING APPROACHES WHEN EVALUATING THE ENGINEERING-GEOLOGICAL CONDITIONS OF TUNNEL CONSTRUCTION.
For primary bibliographic entry see Field 8E.
W91-07629

PRECAST PLIANT LINING FOR DIFFICULT GEOLOGICAL CONDITIONS.
For primary bibliographic entry see Field 8G.
W91-07630

IMPROVEMENT OF SUPPORTS IN TUNNEL CONSTRUCTION UNDER COMPLEX GEOLOGICAL CONDITIONS.
D. G. Gudushauri, and A. I. Chaldze.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 4, p 234-236, 1990. 1 fig, 6 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 4, p 14-16, April, 1990.

Descriptors: *Construction methods, *Hydraulic engineering, *Hydroelectric plants, *Structural engineering, *Tunnel construction, *Tunnel failure, Concretes, Deformation, Geologic formations, Load distribution, Reinforced concrete, Rock mechanics, USSR.

Construction of the large tailrace tunnel of the Zhinvali (USSR) hydroelectric station was carried out under complex geological conditions. Because of intense ventilation during construction, the rocks lose strength properties from the effect of the moist air and they became unstable, in which case the elastic stress zone gradually moved deep into the mass and had a substantial effect at first on deformation of the temporary supports and then on deformation of the permanent supports. Steel-concrete supports with a high load-bearing capacity were used for supporting the tailrace tunnel in the section of unstable rocks. However, the supports also could not withstand the high rock pressure. The rigid temporary supports were replaced by yielding arch supports, which led to exfoliation and rock falls. It was concluded that the cause of failure of supports lies not in the designs themselves or in their incorrect choice for the existing conditions but rather in the method of construction. A new technological method of constructing permanent supports of workings under complex geological conditions has been developed, which makes it possible to bring the strength of the concrete mix to the desired value before the load acts on it, after which it is loaded by the weight of the actually insignificant magnitude of the side rocks. Immediately after driving the tunnel, a curved floor arch is installed edgewise on a concrete slab on the floor. Side props are inserted at the ends of this segment, and the remaining sets of frames of the tubular or steel support are constructed by the same method, joined together by clamps and bars. After constructing the necessary number of temporary supports at a certain distance from the walls of the working, a two-sided form is constructed at the distance of approximate displacement of the side rocks and filled with concrete mix. The reinforced concrete support is constructed the same way and further construction is carried out. Thus, by means of the temporary support, which exerts an active resistance to rock pressure, the concrete mix reaches its maximum strength without the effect of rock pressure. (Fish-PTT)
W91-07631

NEW DESIGNS OF SUPPORTS FOR LARGE CHAMBER WORKINGS.
For primary bibliographic entry see Field 8E.
W91-07632

DEFORMATION PROPERTIES OF ROCKS OF THE DIVERSION PRESSURE TUNNEL OF THE INGURI HYDROELECTRIC STATION.
For primary bibliographic entry see Field 8E.
W91-07633

CONSIDERATION OF THE ANISOTROPIC PROPERTIES OF STRATIFIED ROCKS WHEN DESIGNING CRACK-RESISTANT LININGS OF PRESSURE TUNNELS.
For primary bibliographic entry see Field 8E.
W91-07634

ECOLOGY AND HYDRAULICS IN THE FUTURE.
V. S. Altunin.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 3, p 149-155, 1990. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 3, p 1-5, March, 1990.

Descriptors: *Dam effects, *Drainage effects, *Hydraulic engineering, *Irrigation effects, *Management planning, *Prediction, *Water resources development, Dams, Design criteria, Ecology, Floods, Irrigation, Reservoirs, Socioeconomic aspects.

At present both hydraulic engineering and reclamation are being criticized for undesirable consequences (flooding and subirrigation of land as a result of reservoir creation, salinization on irrigated lands and depreciation of the quality of collector-drain waters, and the need for irrigation on overdrained lands). For contemporary water-management construction, ecological criteria (requirements) were developed to scientifically evaluate the new water projects and reclamation activities. The first criterion is socioeconomic; usually it conflicts with preservation and the stability of an ecosystem in a natural state as a result of the need to develop various sectors of the economy. The second criterion of the stability of the ecosystem determines the possibility of water-management construction and is related to the relative size of the area affected and depth of the effect (to ground waters) in the territory of the drainage basin. The third ecological criterion of water-management construction requires the observance of a certain technology of construction (lightweight agricultural equipment not disturbing the structure and fertility of the soil layer, limitation of the number of trips to 5-6 during agricultural production, including treatment with non-toxic chemical fertilizers, and irrigation methods (mist, drip, or subsurface irrigation). The fourth ecological criterion is based on the theorem of the edge effect and requires preservation of regions of the land (e.g., bogs) and relief of the locality, which are the source of diversity of the flora and fauna. The fifth ecological criterion cover construction and operation. In the Soviet Union, construction and operation problems characterize most water-management construction as a result of bad management, low quality of construction, and inept planning without due technical and economic substantiation of water-management projects, introduction of outdated technologies, and nonfulfillment of any ecological criteria. (Rochester-PTT)
W91-07875

COMPREHENSIVE EXPERT EVALUATION OF THE ECOLOGICAL CONSEQUENCES OF THE CONSTRUCTION OF HYDROPOWER FACILITIES.
N. I. Khrisanov, N. I. Kerro, and G. A. Kol'nik.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 3, p 156-161, 1990. 3 fig, 1 tab, 8 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 3, p 5-9, March, 1990.

Descriptors: *Dam construction, *Environmental impact, *Evaluation, *Hydroelectric power, *Project planning, *Reservoirs, Experts, Feasibility studies, Prediction, Probabilistic process.

Hydropower construction, which concerns the construction of dams and the creation of reservoirs, can lead to negative ecological consequences. At present consideration of possible changes in environmental conditions is considered at the feasibility study stage. However, it is rather difficult when working out the feasibility study to determine all possible changes in the environment in the zone of influence of the hydro development and their quantitative indices. A method was developed that is based on questioning of experts and incorporating this information into comprehensive prediction of environmental impact. The method is based on systems analysis and decision-making theory. The opinions of experts are collected and analyzed in a step-wise manner to yield and overall conclusion. This method was applied to the Gilyui hydro development; view of 23 experts were incorporated into the analysis. The method permitted the rating of factors with the following results in terms of their significance. 'Flooding of the territory' was the most significant group of factors; within this group 'flooding of the forests' was most significant. Next in significance were 'change in the hydrological regime' and 'change in water quality.' Less significant were 'change in climate' and 'change in landscape.' An analysis of the results revealed a rather high agreement in the answers of the specialists, with a confidence coefficient, p, of 99%. The process permitted the most significant potential environmental effects of the Gilyui hydro development to be identified at the feasibility study stage so that more design effort could be devoted to them. (Rochester-PTT)
W91-07876

SUBSTANTIATION OF PARAMETERS OF FLOOD CONTROL ENGINEERING OF THE NORTHEAST COAST OF THE CASPIAN SEA.
Y. A. Litvin, A. A. Dzhaliov, and K. I. Mashkovich.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 3, p 162-167, 1990. 5 fig, 2 tab, 6 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 3, p 9-12, March, 1990.

Descriptors: *Caspian Sea, *Dikes, *Embankments, *Flood control, *Levees, *Sea level, Design criteria, Forecasts, Frequency distribution, USSR, Wave runup, Wind tides.

The northeast coast of the Caspian Sea in the stretch between Komsomolets Bay and Botakhan village represents a flatland territory subjected to flooding during wind setups as a result of which a territory up to 15 km inland is covered with sea water for several days. An analysis of the hydrodynamics of this area was conducted with the aim of determining what flood control measures would be needed. Based on the calculations, the value of the extreme setup possible once in 50 yr will be 240-260 cm. Since the values of the setup rise of the level are determined at the water line and the slope of the shoreline is approximately constant, the value of the rise of the level due to wind setup is practically independent of the position of the sea level at a given time. Most complex is the problem of determining the absolute value of the elevation of the water level during setup. This is because a long-range forecast of the Caspian Sea level presently remains controversial. A base level of -27.3 m is agreed upon for designing the levee, and thus the maximum elevation of the level with consideration of setups of 2% probability will be -24.5 m. This value of the wind-driven rise of the level with additional consideration of the height of the wind wave and runup on the protective wall should be selected as the base when assigning the elevation of the levee crest. (Rochester-PTT)
W91-07877

MEASUREMENT OF UPPER POOL LEVELS OF A HIGH DAM DURING CONSTRUCTION.
V. I. Bryzgalov, and A. D. Shusharin.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 3, p 200-203, 1990. 2 fig, 5 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 3, p 31-33, March, 1990.

Descriptors: *Dam construction, *Economic aspects, *Hydroelectric plants, *Measuring instruments, *Turbines, *Water level, Cost analysis, Gaging, Manometers, Monitoring, Sayano-Shushenskoe Hydrostation, USSR.

Starting a medium-head turbine-generator unit at a higher dam while the dam is still under construction can have significant economic benefit. Immediately after start-up of the first unit at a hydrostation under construction, the need arises for the systematic performance of numerous monitoring functions, one of which is monitoring of the levels of the upper and lower pools of the hydrostation. At the Sayano-Shushenskoe hydrostation (Soviet Union), a method of remote measurement of the upper pool levels using an accurate differential manometer of relatively small measurement range was proposed and introduced. For this purpose, a special system of compensating for the pressure of the upper pool was employed so that the exact range of the meter could be used repeatedly for a large variation in upper pool level. The ability to obtain remote measurements of the upper pool levels at the Sayano-Shushenskoe hydrostation during construction made it possible to markedly reduce the labor intensity of the monitoring by eliminating manual measurements by the team on duty. The annual economic effect of using the upper pool level gage was exceeded 20,000 rubles and the quality and reliability of the measurements was increased. (Rochester-PTT)
W91-07883

MINGTAN PUMPED-STORAGE PROJECT IN TAIWAN.
Taiwan Power Co., Taipei.
S. C. Liu, and C. S. Hsieh.
International Water Power and Dam Construction IWPCDM, Vol. 43, No. 2, p 9-15, February 1991. 10 fig.

Descriptors: *Dam construction, *Mingtan Hydroelectric Plant, *Pumped storage, *Taiwan, Civil engineering, Hydraulic design, Reservoirs, Sun Moon Lake, Turbines, Underground structures.

Taiwan's second major pumped-storage plan, now under construction, is the 1600 MW Mingtan scheme. It will provide a much needed improvement in Taipower's ability to meet demand with a flexible supply. The geological setting of the area is complex, causing difficulties for the construction of the pressure tunnels, surge tanks, penstocks, and power and transformer caverns. The reinforcement method developed to ensure the stability of the exceptionally large power cavern (22 m x 46 m x 158 m) in a poor rock mass (metamorphic sandstones and siltstones) is being used for the first time in Taiwan. The intake structure of the project comprises an approach channel, two parallel funnel-shaped inlets, two gate shafts, and two transition sections. The twin headrace tunnels each will have a 7.5-m inside diameter and a length of 3.1 km. The pressure tunnels will cross the Tousheh River. Two surge tanks of the restricted orifice type will be included. Two steel penstocks with a diameter of 6.8 m will empty into manifolds, which discharge into each of the six pump-turbines. The power cavern is designed to hole six 275-MW pump-turbine units of the reversible Francis type. There are six tailrace tunnels (inside diameter 5 m). The existing Sun Moon Lake will serve as the upper reservoir and the Shuili Dam, a concrete gravity dam 319 m long and 61.5 m high, will be constructed to impound the lower reservoir. (Rochester-PTT)
W91-07889

PUMPED-STORAGE PROJECTS UNDER CONSTRUCTION IN JAPAN.
Electric Power Civil Engineering Association, Tokyo (Japan).
T. Kokusho.
International Water Power and Dam Construction IWPCDM, Vol. 43, No. 2, p 15-19, February 1991. 5 fig, 4 tab.

Descriptors: *Dam construction, *Hydroelectric plants, *Japan, *Pumped storage, *Reservoirs, Hydraulic design, Linings, Peaking capacity, Pilot plants, Turbines, Underground structures.

Thirty-eight pumped-storage power stations were in operation in Japan as of March 1989. Their total capacity is around 17,000 MW, which accounts for 10% of the total installed capacity of the electric power system in Japan. Eight pumped-storage stations are under construction. Examples of these are the Sabigawa, Okumino, and Ohkawachi are conventional pumped-storage plants, whereas the Kunigami plant is a seawater pumped-storage plant. The Sabigawa station (on the Saba River in Tochigi Prefecture) is a pure pumped-storage plant of 900 MW capacity at a maximum discharge of 324 cu m/sec. It will use a 90.5 m-high rockfill dam with an asphaltic facing and a 104 m-high concrete gravity dam as upper and lower dams, respectively. The Okumino project will involve three dams, two on the upper regulating reservoir. The project, which is Gifu Prefecture, will have 1000 MW output and is expected to begin supply-

ing peaking power in 1994. The Ohkawachi pumped-storage project (Hyogo Prefecture) uses water from the Inumi River, a tributary of the Ichi River. It has an installed capacity of 1290 MW and is capable of supplying daily peaking power for 6 hr. Four pump-turbine/generator-motor units will be housed in a powerhouse 280 m below ground. The Kunigami seawater pumped-storage plant is a pilot plant of 30 MW rated capacity. It is located in Okinawa Prefecture and will use an upper reservoir lined with synthetic rubber sheeting to prevent seawater from seeping into the ground. The lower reservoir will be the Pacific Ocean. Observations conducted over 5 yr of operation will focus on corrosion of equipment and the effects of seawater spray on local vegetation. (Rochester-PTT)
W91-07890

ROCKY MOUNTAIN PROJECT WILL PROVIDE PEAK POWER FOR GEORGIA.
Oglethorpe Power Corp., Tucker, GA.
D. R. Murphy, and W. R. Ivarson.
International Water Power and Dam Construction IWPCDM, Vol. 43, No. 2, p 22-24, February 1991. 3 fig.

Descriptors: *Dam construction, *Georgia, *Hydroelectric power, *Pumped storage, Civil engineering, Design criteria, Multipurpose projects, Powerhouses, Recreation facilities, Reservoirs.

An 800 MW pumped-storage project is under construction at Heath Creek in Floyd County, Georgia. The aim of this project is to improve the reliability of the system operated by the Ogelthorpe Power Corporation. There have been some significant changes in electrical equipment because of the length of time the project has been under development, but other project features have remained little altered. The upper reservoir will be impounded by a continuous earth and rockfill dam approximately 3900 m long, 23 m high on average, and with a crest elevation of 427 m above sea level. The lower operating reservoir will be impounded by a 168 m-long main earthfill dam with its crest elevation at 220 m; a 146 m-long concrete gravity structure, with a gated spillway; and a cut-off trench excavated approximately 213 m into the right abutment and backfilled with zoned earthfill up to 220 m elevation. The powerhouse will be a conventional surface (concrete) structure containing three reversible pump/turbine units, each of which is rate at 263 MW at 187 m minimum net head. Each will be connected directly to a motor/generator rated at 314 MVA, with a 0.9 power factor (at 60 C rise). Recreational facilities for the public will be provided as part of the project. It is estimated that there will be about 95,000 visits to the project and recreation facilities annually by 2000. (Rochester-PTT)
W91-07891

SOME CHARACTERISTICS OF CONSTRUCTING THE UNDERGROUND MACHINE HALL AT THE KOLYMA HYDROELECTRIC STATION.
G. Y. Gevirts, V. V. Koleganov, and V. M. Mostkov.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 5, p 305-313, 1990. 8 fig, 2 tab, 5 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 5, p 24-29, May, 1990.

Descriptors: *Construction, *Construction methods, *Hydroelectric plants, *Permafrost, *Structural engineering, *Underground structures, Engineering geology, Freezing, Hydraulic machinery, Kolyma Hydrostation, Rock mechanics, USSR.

The experience in constructing the underground machine hall in a frozen rock mass thawing during operation at the Kolyma hydrostation has practical significance for the design and construction of similar underground structures. The main requirements imposed on the creation of reliable underground structures having a large cross section under permafrost conditions are: comprehensive consideration at the design stage of the engineering--geological, cryogenic, hydrogeological, temperature, and other conditions of the surrounding rocks, including the structure and initial state of the mass, established by specific experimental works; substantiation of designs taking into account the change in the deformation and stress-strain state of the rock mass and conditions of performing the works; creation of primarily yielding designs of the linings (support) able to absorb nonuniform loads without disturbing their continuity under conditions of specially constructed drainage systems for removing seepage waters; and thorough observations of the state of the rock mass during driving. On-site observations, investigations, and calculations confirmed the effectiveness of the strengthening measures performed on the arch of the machine hall of the Kolyma hydrostation. It is recommended that the on-site observations be continued until complete stabilization of movements in the arch and surrounding rocks. (MacKeen-PTT)
W91-08031

UNDERGROUND PNEUMATIC SURGE TANKS OF HYDROELECTRIC STATIONS.
V. L. Kuperman.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 5, p 313-319, 1990. 8 fig, 7 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 5, p 30-34, May, 1990.

Descriptors: *Compressed air, *Hydraulic properties, *Hydroelectric plants, *Underground structures, *Water level, Economic aspects, Environmental effects, Hydraulic engineering, Hydraulic systems, Pneumatic surge tanks, Surge tanks, Water level fluctuations.

A pneumatic surge tank is a tank in which the water fluctuations occur in a closed chamber with an internal air pressure exceeding atmospheric pressure. Due to the high air pressure, the range of water fluctuations during load changes at the hydrostation is reduced considerably, which accordingly reduces the necessary height of the tank. Calculation of the hydraulic regime of a pneumatic surge tank was carried out by the direct solution of equations of fluctuation of liquid masses in a pressure system with compressed air in the tank. The decrease of the load, the stability of operation of the tank in the case of finite load fluctuation, and the hydraulic resistances in the tank are important characteristics of the pneumatic surge tank. An underground surge tank was designed to replace a differential surge tank with a height of more than 30 m and a diameter of 12.5 m. It is concluded that the use of an underground pneumatic surge tank improves the economic index and minimizes the environmental effects of the hydroelectric plant. (MacKeen-PTT)
W91-08032

REGULATION OF THE TEMPERATURE REGIME OF LOWER POOLS OF HIGH-HEAD HYDRO DEVELOPMENTS.
V. E. Lyapin.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 5, p 329-335, 1990. 3 fig, 2 tab, 18 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 5, p 41-45, May, 1990.

Descriptors: *Dam effects, *Hydroelectric plants, *Reservoirs, *Temperature control, *Water temperature, Environmental effects, Intakes, Krasnoyarsk Hydrostation, Seasonal variation, Siberia, Soviet Union, Thermal stratification, USSR.

The temperature regime of reservoir and lower pools at the Krasnoyarsk hydroelectric development, Siberia, Soviet Union, was studied. The flow intensity in the reservoir exceeds 0.5 sq m/sec. After formation of the ice cover, usually in December, inverse stratification occurs, with an extremely nonuniform distribution of temperatures within the active zone. (20-23 C at the surface to 4-6 C at the interface at a depth of 50-60 m). The change in temperature regime due to the hydroelectric plant worsened the habitat conditions of valuable fish species. One of the main measures which can provide approximation of the temperature regime in the lower pool to that which existed before construction of the plant is the selective withdrawal of the surface layers of the reservoir. Laboratory investigations indicated that the use of selective withdrawal brings the temperature regime of the lower pool close to the natural one. The surface intake of water would provide a water temperature at the turbine outlet of 16-18 C in the summer and 1-1.5 C in the winter. Proposed measures to improve the ice and temperature regime in the lower pool of the Krasnoyarsk hydrostation include construction of a surface intake along the entire dam of the hydrostation and reduction of the fluctuation of the level in the region of formation of the ice edge. (MacKeen-PTT)
W91-08035

OPTIMIZATION OF THE FORM OF A CONCRETE ARCH DAM.
For primary bibliographic entry see Field 8F.
W91-08037

8B. Hydraulics

CAVITATION IN CHUTES AND SPILLWAYS.
Bureau of Reclamation, Denver, CO.
H. T. Falvey.
A Water Resources Technical Publication Engineering Monograph No., 42, April 1990. 145p, 75 fig, 13 tab, 91 ref, 5 append. Also includes three 5-1/4 inch floppy diskettes containing the program Cavitation in Chutes and Spillways, v 1.0.

Descriptors: *Cavitation, *Chutes, *Spillways, Aeration, Aerators, Computer programs, Geometry, Hydraulic properties, Hydraulic structures, Overflow channels, Theoretical analysis.

This report presents highlights of cavitation theory to give the reader a sense for the basic mechanisms that must be understood before engineering problems and solutions can be discussed. The report is expected to give the designer of hydraulic structures both an understanding of cavitation and the design tools necessary to eliminate or reduce the damaging effects of cavitation in hydraulic chute and spillway structures. In the report: Chapter 1 discusses highlights of cavitation theory; Chapter 2 presents cavitation characteristics of typical surface irregularities; Chapter 3 is a discussion of cavitation damage; Chapter 4 treats the influence of geometry; Chapter 5 addresses aeration and aerators; Chapter 6 contains recommendations for designers; and Chapter 7 concludes with selected Bureau of Reclamation field experiences. Several appendices are included which describe computer programs useful in the analysis of specific geometries: Appendix A contains the algorithms to calculate the cavitation and damage indexes for open channel flow situations; Appendix B describes a program to plot the cavitation and flow characteristics; Appendix C contains descriptions of two programs to investigate the effect of changes in the invert geometry on the cavitation index; Appendix D contains a description of a computer code used to design aerators; and Appendix E contains the description of a program to determine the damage potential of a structure using historical data. (Lantz-PTT)
W91-07189

SIMULTANEOUS, MULTIPLE-LEVEL WITHDRAWAL FROM A DENSITY STRATIFIED RESERVOIR.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
S. E. Howington.
Available from the National Technical Information Service, Springfield, VA 22161. Technical Report W-90-1, November 1990. Final Report. 73 p, 33 fig, 30 ref, append.

Descriptors: *Mathematical models, *Reservoirs, *Selective withdrawal, *Stratified flow, Flow pattern, Mathematical analysis, Reservoir operation.

A theory was developed and tested to predict the distribution of flow among multiple ports in a density stratified fluid (e.g., a thermally stratified reservoir). Knowledge of the individual port flows is necessary to accurately estimate the release water characteristics using correct selective withdrawal technology. The comparisons between the

predictions and observations encompass a wide range of intake structure sizes, port configurations, and flow rates. The comparisons were favorable with the only significant errors limited to an unlikely range of operating conditions. For a large percentage of potential flows, the resulting stratified flow distribution algorithm can predict, with reasonable accuracy, the individual port flows and the desired water quality constituents. This has been incorporated into a subroutine for inclusion in numerical reservoir models. (Lantz-PTT)
W91-07211

DREDGING ALTERNATIVE STUDY, CUBITS GAP, LOWER MISSISSIPPI RIVER. REPORT 1: TABS-1 NUMERICAL MODEL INVESTIGATION.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
R. C. Copeland.
Available from the National Technical Information Service, Springfield, VA 22161. Technical Report HL-90-20, January 1991. Report 1 of a Series. 78 p, 22 tab, 21 plates, 18 fig, 7 ref.

Descriptors: *Cubits Gap, *Dredging, *Mathematical models, *Mississippi River, *Model studies, *TABS-1 Model, Hydrographs, Sediment transport, Sedimentation.

A numerical model study was conducted of the Mississippi River to evaluate dredging alternatives in the Cubits Gap and Head of Passes reaches. The TABS-1 one-dimensional model was used. The model was adjusted to reporting dredging quantities in Southwest Pass over a period of several years. The model was circumstantiated by reproducing dredging at Cubits Gap in 1989. An 11 year hydrograph was used to determine annual dredging requirements for existing conditions. Alternatives that included advance maintenance, a sediment trap, and flow reduction in Cubits Gap were compared to existing conditions. The advance maintenance and Cubits Gap flow reduction alternatives were determined to be the most effective in terms of the percent of time that project depth could be maintained. The flow reduction alternative provided for a significant decrease in total dredging requirements. (Lantz-PTT)
W91-07212

CUMBERLAND SOUND AND KINGS BAY PRE-TRIDENT AND BASIC TRIDENT CHANNEL HYDRODYNAMIC AND SEDIMENT TRANSPORT HYBRID MODELING. VOLUME I: MAIN TEXT AND APPENDIXES A, C, AND D.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
M. A. Granat, and N. J. Brogdon.
Available from the National Technical Information Service, Springfield, VA 22161. Technical Report HL-90-21, December 1990. Final Report. 190 p, 27 fig, 4 append.

Descriptors: *Channel flow, *Cumberland Sound, *Dredging, *Hydraulic models, *Hydrodynamics, *Kings Bay, *Mathematical models, *Model studies, *Sediment transport, *Trident Channel, Flow profiles, Georgia, Tidal hydraulics.

A verified hybrid modeling system (coupled physical and numerical models) of the Kings Bay/Cumberland Sound estuarine system was used to investigate hydrodynamic and sedimentation variations associated with Trident channel expansion. The models generally demonstrated small velocity differences between the pre-Trident base channel condition and the enlarged Trident channel condition tested. Reduced velocity magnitudes in the deepened upper Kings Bay turning basin demonstrated the largest base-to-plan velocity differences. Tidal effects were examined; the tested plan condition resulted in higher high-water and mid-tide level elevations in both the physical and numerical models. Variations were close to, but greater than, detection limits. Low water elevations between the models were inconsistent. Based on more recent field data, it was concluded that tide range will probably not change as a result of Trident channel improvements. The subtle base-to-plan hydrodynamic differences and the increased plan channel area resulted in dramatic sedimentation responses. The numerical model predictions indicated a 150% increase in required annual plan channel maintenance dredging. Based on the previous shoaling history and this study's findings, the typical annual plan channel maintenance dredging requirement is predicted to vary from a low of about 0.9 million cu yds/yr to a high of about 4.9 million cu yds/yr. The long-term average submarine channel maintenance is predicted to increase from approximately 1.0 million cu yds/yr for pre-Trident channel conditions to approximately 2.5 million cu yds/yr for the Trident channel condition. (Lantz-PTT)
W91-07214

DREDGING ALTERNATIVES STUDY, CUBITS GAP, LOWER MISSISSIPPI RIVER. REPORT 2: TABS-2 NUMERICAL MODEL INVESTIGATION.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
For primary bibliographic entry see Field 7C.
W91-07216

RIO PUERTO NUEVO FLOOD-CONTROL PROJECT, SAN JUAN, PUERTO RICO: HYDRAULIC MODEL INVESTIGATION.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
R. L. Stockstill, and J. R. Leech.
Available from the National Technical Information Service, Springfield, VA. 22161 as AD-A231076. Price codes: A09 in paper copy, A01 in microfiche. Technical Report HL-90-18, October 1990. Final Report. 75p, 4 fig, 19 tab, 23 photos, 75 plates.

Descriptors: *Channels, *Diversion structures, *Flood control, *Hydraulic models, *Rio Puerto Nuevo Basin, Channel flow, Data acquisition, Design standards, Diversion channels, Flow velocity, Hydraulic structures, Puerto Rico.

Three models were used to study portions of the high velocity reaches within the Rio Puerto Nuevo basin. A 1:35-scale model of the Puerto Nuevo Channel was tested to determine the flow conditions in the transitions and curves in the supercritical channel, at the junctions with the Guaracanal Channel and Buena Vista Diversion Channel, at the bridges, and in the reach of the channel where the flow transitions from supercritical to subcritical flow. Tests were conducted on a 1:25-scale model of the Josefina Channel to determine the flow conditions at the junction with the Dona Ana Channel and where the flow transitions from supercritical to subcritical flow. A 1:35-scale model of the Margarita Channel was also studied to determine the flow conditions in the vicinity of the De Diego Expressway Bridge and where the flow transitions from supercritical to subcritical flow. Flow velocities in the Puerto Nuevo Channel were slightly higher and standing waves created by disturbances were significantly higher with the smaller n value. The recommended design incorporates into the original proposed design straightening the channel walls from sta 205+57.70 to 204+86.94, extending the Puerto Nuevo Channel/Buena Vista Diversion Channel confluence wall 70.76 ft downstream, adding debris noses on the Pinero Avenue Bridge piers, extending the Las Americas Expressway Bridge piers upstream to sta 158+53.85, and adding two rows of 10-ft-high by 10-ft-wide baffle blocks followed by six rows of 4-ft-high by 4-ft-wide baffle blocks between sta 150+40 and 148+34). The confluence of the Josefina and Dona Ana Channels provided an appropriate transition to converge the flow of the two channels. An oblique standing were observed downstream of the confluence did not cause adverse effects downstream and was considered acceptable. Curves in the proposed design maintained acceptable water-surface elevations throughout the test section. Tests conducted with the Margarita Channel model to determine the flow conditions in the vicinity of the De Diego Expressway Bridge indicated that the original design passed discharges </= 9,900 cu ft/sec under the bridge. The original design resulted in unacceptable flow conditions in the transition reach of the channel. (Lantz-PTT)
W91-07245

DETERMINATION OF INCOMPRESSIBLE AND STATIONARY FLOW THROUGH N PARALLEL BRANCHES (DETERMINATION DE L'ECOULEMENT INCOMPRESSIBLE ET STATIONNAIRE A TRAVERS N BRANCHES EN PARALLELE).
Ecole Polytechnique Federale de Lausanne (Switzerland). Dept. de Mechanique.
R. Flatt.
Houille Blanche HOBLAB, Vol. 1990, No. 6, p 441-444, 1990, 2 fig, 2 ref. English summary.

Descriptors: *Conduits, *Head loss, *Hydraulic head, *Hydraulics, *Hydroelectric plants, *Steady flow, Algorithms, Hydraulic engineering, Network analysis, Pumps, Turbines, Valves.

A hydroelectric installation generally consists of a system of parallel conduits, which may contain turbines, pumps, and/or valves. The mathematical models which describe such systems are nonlinear. A linear electrical analogy (Ohm's law) provides the basis for an algorithm with very good convergence, which permits the determination of flow distribution in such networks of parallel conduits. The solution of the algorithm is iterative and begins by establishing an initial distribution of flow volumes. The second step consists of evaluating, branch by branch, the pressure change attributable to each branch's flow volume. A heuristic element (which has not been subjected to rigorous mathematical proof) is introduced: The general pressure change is replaced by the specific pressure change obtained from the two preceding iterations. Besides the parallel-conduit hydraulic application, this algorithm could be used very generally for analogous problems of parallel branching which are also characterized by the conservation of flow, such as the flow volume of a stationary compressible discharge. (King-PTT)
W91-07532

EXACT SOLUTION OF BOUSSINESQ EQUATIONS FOR SHALLOW WATER MOTION (IN CHINESE).
Academia Sinica, Qingdao (China). Inst. of Oceanology.
C. Y. Li.
Oceanologia et Limnologia Sinica (Hai Yang Yu Hu Chao) HYHCAG, Vol. 21, No. 3, p 236-240, 1990, 1 fig, 11 ref. English summary.

Descriptors: *Boussinesq equation, *Fluid dynamics, *Wave crest, *Wave propagation, *Wavelengths, *Waves, Wave height.

An exact solution is derived for the Boussinesq equations of the motion of solitary shallow waves. Boussinesq equations are nonlinear and weakly dispersive and are related to KdV equations. The zeroth order solution is unique and has a discontinuity of the first order at the peak of the wave. The first order solution has the same form as the KdV equations. The exact solution is implicit, but the profile of the wave can be obtained explicitly. Except at the peak, the exact solution is the largest, the first order equation is the second largest and the zeroth order equation is the smallest. The horizontal scale of the zeroth order solution is about half as large as the first order and the exact solutions. (Author's abstract)
W91-07534

VARIATION BEHAVIOUR OF TIDAL STAGES IN CHANGJIANG RIVER ESTUARY AND ITS ENGINEERING SIGNIFICANCE (IN CHINESE).
H. X. Xu.
Oceanologia et Limnologia Sinica (Hai Yang Yu Hu Chao) HYHCAG, Vol. 21, No. 4, p 311-319, 1990, 8 fig, 1 tab, 4 ref. English summary.

Descriptors: *Changjiang River, *Estuaries, *Harbors, *Hydrodynamics, *Tidal waves, *Tides, China, Dredging, Hydraulic engineering, Shanghai, Tidal hydraulics, Wave propagation.

The North Passage in the Changjiang (Yangtze) estuary is the main channel for large vessels calling on the port of Shanghai. The channel is shallow and requires a great deal of maintenance dredging. The relationship between the variation of key river levels and the dredging, survey work and engineering was analyzed. Data from 11 stations in the estuary for a period of one year and the theory governing the tidal action of shallow waves were used to analyze in detail of the propagation and deformation processes of tidal action in the Changjiang estuary. The general periodic variation and the non-linear variation at tidal stages are described. The hydrodynamic set-up in the estuary is the natural result of the movement of tidal based waves and not distributions of tidal stages with distance. (King-PTT)
W91-07537

SEDIMENT MANAGEMENT WITH SUBMERGED VANES: I. THEORY.
Iowa Univ., Iowa City. Dept. of Civil and Environmental Engineering.
A. J. Odgaard, and Y. Wang.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 117, No. 3, p 267-283, March 1991. 9 fig, 27 ref. National Science Foundation grant number CTS-8611147.

Descriptors: *Erosion control, *Flow control, *Hydraulic engineering, *River flow, *Sediment control, Bed load, Channel morphology, Flow pattern, Flow velocity, Hydraulic structures, River beds.

Sediment management, in particular the control of sediment movement, scour, and deposition, is one of the most difficult problems encountered by river engineers. Recent research results with the submerged-vane technique for sediment control in rivers was examined. Submerged vanes are small flow-training structures (foils), designed to modify the near-bed flow pattern and redistribute flow and sediment transport within the channel cross section. The structures are installed at an angle of attack of 15-25 degrees with the flow, and their initial height is 0.2-0.4 times local water depth at design stage. The vanes function by generating secondary circulation in the flow. The circulation alters magnitude and direction of the bed shear stresses and causes a change in the distributions of velocity, depth, and sediment transport in the area affected by the vanes. As a result, the river bed aggrades in one portion of the channel cross section and degrades in another. The vanes can be laid out to develop and maintain any desired bed topography. The main uncertainties in the calculations are associated with the transverse bed-slope factor (B) and the velocity-profile factor (k). Factor B represents the bed sediment's motion-resistance properties. Its value has been reported to range from three to six, possibly depending in sediment gradation. Factor k is the ratio of the flow velocity's depth-averaged value to its value in the near-bed layer affected by the vanes. These calculations were performed with $B = 4$ and $k = 1$. Velocity and depth distributions calculated with these values of B and k are in good agreement with measurements. Vanes have been used successfully for protection of stream banks against erosion and for amelioration of shoaling problems at water intakes and bridge crossings. (See also W91-07589) (Fish-PTT)
W91-07588

SEDIMENT MANAGEMENT WITH SUBMERGED VANES: II. APPLICATIONS.
Iowa Univ., Iowa City. Dept. of Civil and Environmental Engineering.
A. J. Odgaard, and Y. Wang.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 117, No. 3, p 284-302, March 1991. 10 fig, 1 tab, 12 ref. NSF grant number CTS-8611147; the Highway Research Board of the Iowa DOT grant numbers HR-255, HR-274, and HR-307; USGS Iowa State Water Resources Research Institute, project number G-1017-03.

Descriptors: *Erosion control, *Flow control, *Hydraulic engineering, *Hydraulic structures, *River flow, *Sediment control, Bed load, Channel morphology, Control flumes, Flow pattern, Flow velocity, Hydraulic design, River beds, Shear stress.

Many different techniques are available for sediment control in rivers. The theory of submerged vanes was tested with laboratory and field data. The laboratory data were from experiments in curved, straight, and recirculating sediment flumes. The field data were from river bends in which, prior to installation of vanes, the banks were eroding, and from a straightened bridge waterway in which sediment deposits were causing a change of channel alignment, bank erosion, and undermining of the bridge abutment. All data support the theory, and they suggest that the vane technique is a viable alternative to traditional techniques. Because of separation on the low-pressure side of the vanes, the relative magnitudes of the induced changes in streamwise and transverse bed shear stress components may not be exactly as calculated. However, the tests clearly suggest that the total stress field is well predicted. The design procedure was illustrated with examples, and vane material and typical vane layouts were examined. Layouts were designed for protection of stream banks against erosion and for amelioration of shoaling problems in navigation channels, at water intakes, in bridge crossings, at river confluences, and at diversions. In most applications, the vane height will be between 0.2 and 0.4 times the local bankfull flow depth, and vane length will be two to three times vane height. The submergence of the vanes will be as much as 100% of the average flow depth. The vanes will be placed in arrays along the bank of the river. One of the still uncertain design variables is the longitudinal distance between the vane arrays; in laboratory tests a spacing of 12-15 times vane height gave good results, but field tests showed that 30 times vane height was nearly as effective. This parameter needs further testing. (See also W91-07588) (Fish-PTT)
W91-07589

PIPE PLUNGE POOL ENERGY DISSIPATOR.
Agricultural Research Service, Stillwater, OK. Water Conservation Structures Lab.
F. W. Blaisdell, and C. L. Anderson.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 117, No. 3, p 303-323, March 1991. 9 fig, 15 ref.

Descriptors: *Energy dissipation, *Hydraulic design, *Hydraulic engineering, *Hydraulic structures, *Plunge pools, *Stilling basins, Cohesionless soils, Mathematical equations, Pipe flow, Pipes, Scour, Spillways, Tailwater, Testing procedures.

A simple stilling basin for pipe culverts and pipe spillways is a plunge pool energy dissipator, used at many farms and flood control and water conservation structures. An extensive program of tests to develop criteria for the design of pipe spillway plunge pool energy dissipators has been devised. The pipe spillway discharge covers a 10-fold range that includes the minimum full pipe flow and a maximum flow exceeding the practical range, a range of pipe invert heights below and above the tailwater level from -2 to +8 pipe diameters, and a 16-fold range of noncohesive bed material sizes. The time development and ultimate size of scour holes was determined. For specified time periods, the flow was stopped and the scouted hole was sectioned using the automatic bed level follower triggered manually to record data. A longitudinal centerline section and about 20 cross sections were recorded together with pertinent test parameters. Computer plots of the centerline section, the deepest cross section, and contours at the water surface and 0.2, 0.4, 0.6 and 0.8 of the maximum depth were used to analyze the scour hole geometry. The scour hole geometry and other test data were expressed in mathematical equations that can be used to predict the time development and ultimate sizes of scour holes in natural noncohesive soils. These equations were found to agree with the test data with a moderate degree of conservatism. These equations can also be used to design riprapped pipe spillway plunge pool energy dissipators. (Author's abstract)
W91-07590

ANALYTICAL SOLUTION FOR DENSITY CURRENTS IN SETTLING BASINS.
Universidade Federal do Parana, Curitiba (Brazil).
A. K. Guetter, and S. C. Jain.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 117, No. 3, p 324-345, March 1991. 9 fig, 1 tab, 24 ref.

Descriptors: *Density currents, *Fluid mechanics, *Hydraulic engineering, *Model studies, *Sediment transport, *Settling basins, *Suspended solids, Flow velocity, Laminar flow, Model testing, Sediment concentration, Sedimentation, Turbulent flow.

Settling basins are extensively used to remove suspended solids from effluents. Experimental information on the magnitude of density currents in settling basins shows that the velocities of sediment-induced density currents near the upstream region of the settling basin are one order of magnitude larger than the flow-through velocities in the basins. Therefore, performance of settling basins is controlled primarily by density currents and not by flow-through velocity. An analytical model has been developed to predict density currents induced by settling solids in rectangular sedimentation basins. The conservation equations for fluid and sediment mass, fluid momentum, and fluid energy, on integration over the flow depth using similarity profiles for concentration and velocity, were reduced to a system of ordinary differential equations solved analytically. Analytical expressions for longitudinal variations of sediment concentration and velocity along the settling basin were developed. The density-induced velocity decreased linearly along the length of the basin for both laminar and turbulent regimes. The decay of sediment concentration was quadratic for laminar flows and cubic for turbulent flows. The analytical results compared reasonably well with the available experimental data. (Author's abstract)
W91-07591

RHEOLOGY OF HYPERCONCENTRATIONS.
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
P. Y. Julien, and Y. Lan.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 117, No. 3, p 346-353, March 1991. 3 fig, 1 tab, 7 ref.

Descriptors: *Flow characteristics, *Flow models, *Model studies, *Rheology, *Sediment concentration, *Sediment transport, Dispersivity, Flow equations, Hydraulic engineering, Shear stress, Turbulent flow, Viscous flow.

The rheology of highly concentrated sediment mixtures has been studied by various researchers. A physically-based quadratic rheological model for hyperconcentrated flows was tested with three different experimental data sets. The model includes components describing: (1) cohesion between particles; (2) viscous friction between fluid and sediment particles; (3) impact of particles; and (4) turbulence. The resulting quadratic formulation of the shear stress was shown to be in excellent agreement with all three of the experimental data sets. When the quadratic model is written in a linearized dimensionless form, the ratio of dispersive to viscous stresses was shown to play a dominant role in the rheology of hyperconcentrations. The quadratic model was best suited when the ratio of dispersive to viscous stresses was between 30 and 400. At low values of this ratio (<30), the quadratic model reduced to the simple Bingham plastic model, and at large values (>400) a turbulent-dispersive model was indicated. (Author's abstract)
W91-07592

UNIFIED THEORY ON POWER LAWS FOR FLOW RESISTANCE.
Geological Survey, Menlo Park, CA. Water Resources Div.
C. Chen.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 117, No. 3, p 371-389, March 1991. 1 fig, 2 tab, 43 ref.

Descriptors: *Flow models, *Flow resistance, *Model studies, *Shear, *Turbulent flow, Flow velocity, Hazen-Williams equation, Hydraulic engineering, Least squares method, Mannings equation, Mathematical studies, Regression analysis, Reynolds number, Roughness coefficient.

Empiricism has played a major role in the development of many power formulas with different exponents (or powers) for the streamwise time-mean-velocity distribution in turbulent shear flows, whereas the logarithmic law is well known for its theoretical soundness and universal validity. Two general power formulas, one for hydraulically smooth flows and the other for fully rough flows, were derived in a rational way from the widely accepted logarithmic formulas for the velocity profile and the Darcy-Weisbach friction factor. A regression analysis based on the method of least squares was used to determine the valid range of the local velocity (or normal distance from the wall) in the power formula. Some older empirical formulas, such as Lacey's, Manning's, Blasius', and Hazen-Williams', and their valid ranges, were actually explained analytically by the results. Incomplete self-similarity of the power law, in which the exponent and the associated coefficient vary with the similarity parameters, such as the Reynolds number and the relative roughness, was elucidated through the parametric representations of the power formulas and their counterparts based on the logarithmic law. Examination of the concept and rationale behind the power formulation of uniform turbulent shear flows thereby addresses some critical issues in the modeling of flow resistance based on the power law. The power law is indeterminate because the exponent and the associated coefficient of the power formula are unknown and in fact constitute part of the solution in the process of developing the power law. (Author's abstract)
W91-07594

FLUVIAL ARMOR.
Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.
G. Parker, and A. J. Sutherland.
Journal of Hydraulic Research JHYRAF, Vol. 28, No. 5, p 529-544, 1990. 6 fig, 1 tab, 24 ref.

Descriptors: *Alluvial channels, *Bed load, *Channel armoring, *Model studies, *River beds, *Sediment transport, Nonuniform flow, Numerical analysis, Particle size, Sediment-water interfaces.

Bed load transport of nonuniform sediments involves the interaction of many processes. Two of these are the tendency toward selective transport by size fraction and the possibility of armor formation. Mobile armor layers which form during bed load transport of nonuniform sediments were shown to be closely related to the static armor layers that form by selective erosion as a result of the action of clear water flows, based on two previously published numerical models of the transport of nonuniform sediments. Each model was inverted, so that it predicted surface layer compositions given the imposed flow conditions and bed load transport rate and composition. Static armor was then obtained in the limit of vanishing sediment transport, under the constraint that the bed load and substrate size distributions were identical. Models developed to predict bed load transport rates and size distribution for nonuniform sediments can be used to predict surface layer composition given the flow and sediment transport parameters. The resultant composition depends on the imposed transport rate, is coarser than the substrate material, and coarsens as transport rate decreases. When taken to the limit of zero transport rate, the models predict coarse layer compositions which have been shown to be equivalent to late-stage parallel degradation (static) armor produced by clear water flow over nonuniform materials. Good agreement was obtained between measured and calculated static armor compositions over the entire grain size distribution. (Fish-PTT)
W91-07596

NEW NUMERICAL/PHYSICAL FRAMEWORK FOR MOBILE-BED MODELLING: PART 2--TEST APPLICATIONS.
Iowa Univ., Iowa City.
For primary bibliographic entry see Field 2J.
W91-07597

PLANE VERTICAL TURBULENT BUOYANT JET.
Patras Univ. (Greece). Dept. of Civil Engineering.
P. Yannopoulos, and G. Noutsopoulos.
Journal of Hydraulic Research JHYRAF, Vol. 28, No. 5, p 565-580, 1990. 7 fig, 1 tab, 21 ref.

Descriptors: *Buoyant jets, *Diffusers, *Eddy diffusion, *Effluent streams, *Hydraulic engineering, *Jets, *Mixing, *Model studies, *Wastewater disposal, Buoyancy, Differential equations, Flow equations, Flow velocity, Hydraulic models, Momentum equation, Nozzles, Turbulent flow.

The disposal of waste effluents into the atmosphere or hydrosphere often leads to the formation of turbulent buoyant jets. In order to dilute the effluent as much as possible, multiport diffusers are commonly used; they may be hydraulically approximated by the plane turbulent buoyant jet provided that the port-number of the diffuser is large, port-spacing short, and the ambient fluid is deep and of large extent. A thorough investigation was made of the plane vertical turbulent buoyant jet on the basis of semi-empirical equations. The integral forms of the momentum and tracer equations were integrated on the basis of an assumption concerning a function of the spreading coefficients. The validity of this assumption has been verified with experimental results reported in the literature. The analysis led to unified analytical expressions concerning the centerline axial velocity and concentration (or excess temperature) distributions. The integral method in conjunction with the assumption of Gaussian profiles for the velocity and concentration were used to reduce three partial differential equations (on continuity, momentum, and tracer written on the basis of acceptable simplifications for such flows) to a set of three ordinary differential equations. The basic closing assumption made was that a function of spreading coefficients is independent of distance. The centerline distributions found are expressed by simple and unique functional forms in the whole range of independent variables and rely on the determination of spreading coefficients on the same set of experiments. (Fish-PTT)
W91-07598

CIRCULAR TURBULENT WALL JETS ON ROUGH BOUNDARIES.
Alberta Univ., Edmonton. Dept. of Civil Engineering.
S. Wu, and N. Rajaratnam.
Journal of Hydraulic Research JHYRAF, Vol. 28, No. 5, p 581-589, 1990. 6 fig, 1 tab, 6 ref.

Descriptors: *Effluent streams, *Hydraulic engineering, *Hydraulic models, *Hydraulic roughness, *Jets, *Mixing, *Model studies, *Wall jets, *Wastewater disposal, Boundary layers, Flow equations, Flow friction, Flow velocity, Roughness coefficient, Shear stress, Turbulent flow.

A circular wall jet is defined as a circular jet issuing from a nozzle with an (almost) uniform velocity tangential to a boundary into a large mass of the same fluid essentially at rest. An experimental study was performed on the characteristics of a circular turbulent wall jet growing on a rough boundary, for values of the relative roughness varying from 0.16 to 2.16. The velocity profiles in the central plane as well as the transverse velocity profiles were found to be similar. This similarity characteristic was improved if the profiles were considered separately in the boundary layer and free-mixing regions. The length scale of the (whole) wall jet as well as the boundary layer thickness grew linearly with the distance from the nozzle but the growth rates increased linearly with the relative roughness. The length scales in the vertical plane were affected by the boundary roughness whereas the transverse expansion was almost unaffected. The velocity scale was found to vary inversely with the distance from the nozzle (x), with the characteristic coefficient decreasing with the relative roughness. The boundary shear stress in the central plane was found to vary inversely with x-squared, and the characteristic skin friction coefficient indicated a rapid linear increase with the relative roughness. (Fish-PTT)
W91-07599

CLASSICAL HYDRAULIC JUMP: LENGTH OF ROLLER.
Ecole Polytechnique Federale de Lausanne (Switzerland). Dept. de Genie Civil.
W. H. Hager, R. Bremen, and N. Kawagoshi.
Journal of Hydraulic Research JHYRAF, Vol. 28, No. 5, p 591-608, 1990. 14 fig, 2 tab, 24 ref, 2 append.

Descriptors: *Channel flow, *Hydraulic engineering, *Hydraulic jump, Flow equations, Froude number, Mathematical equations, Reynolds number, Turbulent flow.

Previous definitions for a classical hydraulic jump (horizontal channel in which wall frictional effects are absent) have neglected a scaling parameter for the longitudinal jump characteristics. Based on extensive experimental observations, a precise definition of the length roller in classical hydraulic jump has been developed. The length of the roller in a classical hydraulic jump may be regarded as a typical length characteristic. Due to the highly turbulent flow both the beginning and the end of the roller are subject to significant fluctuations. Distinction between the developed and the nondeveloped roller flow was made, and the nondeveloped roller flow was excluded for length measurements. The attempt was made to define developed roller flow for which the roller becomes quasi-steady, and its length corresponds to a time-averaged maximum. Four series of experiments, including more than 140 individual runs and conducted in three different channels, allowed definition of the length ratio by semi-empirical means. It was found that the length ratio for small inflow Froude numbers depends only on the Froude number. For a Froude number >8, the effects of the inflow Reynolds number, and the inflow aspect ratio became notable. The present data are however insufficient for the definition of a generalized length equation. The comparison with published length data is surprisingly good, considering the weakness of roller end definition on which the observations were based. (Fish-PTT)
W91-07600

INTEGRAL EQUATION SOLUTION FOR THE BREAKWATER GAP PROBLEM.
Canterbury Univ., Christchurch (New Zealand). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2L.
W91-07601

STABILITY OF GRADUALLY VARYING FLOW IN WIDE OPEN CHANNELS.
Technische Hogeschool Delft (Netherlands). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W91-07602

MECHANISM OF FAILURE OF FRACTURED BLOCK MASSES UNDER THE EFFECT OF A HIGH-VELOCITY FLOW.
Y. G. Zharkov.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 4, p 270-276, 1990. 6 fig, 8 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 4, p 37-41, April, 1990.

Descriptors: *Channel erosion, *Flow velocity, *Hydraulic engineering, *Hydraulic fracturing, *Hydraulic models, *Uplift pressure, Closed-conduit flow, Flow measurement, Flow models, Flumes, Geologic fractures, High flow, Hydraulic loading, Mechanical failure, Rock mechanics, USSR.

The boundaries of a water flow often represent surfaces cut by a system of fractures into separate elements (protective coverings of stream beds by means of concrete blocks or slabs separated by

expansion joints, etc.), and the few studies of the stability of blocks have far from completely revealed the characteristics of the hydrodynamic process occurring under the effect of the flow on a fractured bed. An investigation was conducted in a hydraulic flume with a width of 50 cm, in which a cube made of organic glass with an edge length of 20 cm was placed in a depression in the bottom. Measurements were taken for two values of the upper pool level and for a gradually varied flow. To determine the relationships characterizing the change in the mean pressure on the upper surface of the rock blocks, experiments were conducted in which the pressure was measured with the use of piezometers located on the upper surface of the rock blocks, experiments were conducted in which the pressure was measured with the use of piezometers located on the upper surface of the block along the longitudinal (along the flow) axial line. Investigations of the effect of a highly turbulent flow on a block were conducted to estimate the value of the height of uplift of a separate element under the effect of a fluctuating load. The investigations showed that: (1) for blocks (slabs) with a smooth surface laid flush with the bottom, under the effect of a high-velocity flow with a uniform motion acting on the blocks, the mean uplift is equal to zero; (2) under the effect of a fluctuating load, the block rises to a small height, which leads to a substantial increase of the mean dislodging load, primarily due to an increase of pressure on the bottom of the block; and (3) in the case of a rock bed, when the sizes of the projections of the natural roughness are an order of magnitude and more greater than the height of uplift of the separate elements under the effect of the fluctuating load, the effect of this load on dislodging a separate element is shown primarily in rupture of the bonds between adjacent blocks, and the main role in dislodging the separate elements is played by the mean uplift. (Fish-PTT)
W91-07637

MOVEMENT AND STORAGE OF SEDIMENT IN RIVERS OF THE UNITED STATES AND CANADA.
Geological Survey, Denver, CO.
For primary bibliographic entry see Field 2J.
W91-07917

TRANSVERSE CIRCULATION AND CHANNEL DEFORMATION NEAR TRAINING WALLS OF BRIDGE CROSSINGS.
A. A. Kurganovich, and O. V. Tovbich.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 5, p 335-337, 1990. 1 fig, 4 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 5, p 45-46, May, 1990.

Descriptors: *Bridges, *Channel flow, *Channel morphology, *Channel scour, *Erosion, *Flow around objects, *Rivers, *Scour, Channel erosion, Design criteria, Model studies, Physical models, Training walls, Water circulation.

The cause of deformations of the bed near the base of training walls of bridge crossings is the presence of transverse circulation in passing flow. A physical model of flow near a wall is proposed and confirmed by experimental observations on erodible models. A flow approaching a training wall bends along a curve concave toward the river. The motion of the flow is characterized by transverse circulation which is characterized as negative. The transverse motion of the bottom filaments retains the same sign due to inertia of motion. The formation of circulation with a positive sign natural for a convex bank begins at the place of departure near the bottom of the channel and is preserved over the entire remaining part of the wall and leads to the formation of channel deposits. To reduce local channel deformations it is necessary to eliminate circulation with a negative sign in the upstream part of the wall. A ribbed wall design was proposed to reduce the local scour pocket near the wall. (MacKeen-PTT)
W91-08036

8C. Hydraulic Machinery

RECOMMENDED PRACTICES FOR TESTING WATER-PUMPING WINDMILLS.
DHV Consulting Engineers, Amersfoort (Netherlands).
D. Veldkamp.
World Bank Technical Paper No. 100, 1989. 26p, 4 fig, 8 ref.

Descriptors: *Pump testing, *Testing procedures, *Water resources development, *Windmills, Pumps, Water resources management, Water supply, Wind.

In November 1986, the World Bank and United Nations Development Program (UNDP) began a project for the Global Windpump Evaluation Program (GWEP) with the following elements: studies on the current position and prospects for wind pumping in a variety of conditions; the writing of a handbook on wind pumping; and the writing of test standards for windpumps and their implementation. This report contains the test standards for windpump testing on test sites. These standards include measurements of atmospheric conditions (wind speed, wind direction, air temperature, air pressure), measurement of parameters of the wind turbine pump (net water output, pumping head, rotor speed), and the actual test procedure. The Test Report should include, but not be limited to: (1) machine under Test, including model and serial number if a production machine; (2) instrumentation including type and location; (3) site layout (including sketch and photographs); (4) data acquisition systems; (5) installation procedures followed; (6) load (transmission, pump and piping system); (7) weather data; (8) data corrections used; and (9) deviations from recommended practice. Raw data summaries should be included as an appendix to the report. Plots of the following should be presented: (1) wind speed probability versus wind speed; (2) net water output versus wind speed; (3) rotor speed versus wind speed; and (4) overall power coefficient versus wind speed. (Lantz-PTT)
W91-07201

SIMULATION OF VALVE CLOSURE AFTER PUMP FAILURE IN PIPELINE.
Oesterreichisches Forschungszentrum Seibersdorf G.m.b.H. Inst. fuer Physik.
M. Suda.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 117, No. 3, p 392-396, March 1991. 2 fig, 3 ref.

Descriptors: *Computer-aided design, *Hydraulic engineering, *Hydraulic valves, *Pipelines, *Pumps, Flow velocity, Optimization, Reservoirs, Water hammer.

In the last few years, some effort has been made to improve computer-optimized methods of valve closure in order to avoid water-hammer effects in a pipeline with a constant flow velocity at the beginning of the closing process. The computerized method of characteristics was used to analyze the effect of pump failure followed by valve closure on water hammer for the simple system of a pump and a single pipeline discharging to a reservoir. A simple but effective valve-closing technique has been developed that throttles the valve quickly to a small opening at the time of flux reversal after pump failure and progresses slowly toward complete closure after a certain amount of time. This procedure has proven to be a useful tool for designing optimal valve control in a pipeline system connected to a pump. (Fish-PTT)
W91-07595

HYDRAULIC DRIVE UNIT FOR OPERATING A GATE.
I. K. Kaplan.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 4, p 277-280, 1990. 1 fig. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 4, p 43-45, April, 1990.

Descriptors: *Hydraulic design, *Hydraulic engineering, *Hydraulic equipment, *Hydraulic gates, *Hydraulic machinery, *Hydroelectric plants, Construction methods, Gates, Transportation, USSR.

At present, hydraulic drives used in hydrotechnical construction as stationary mechanisms for operating gates generally consist of individual components (hydraulic cylinder, support, oil-pressure system, hydraulic panels, pipeline system, gate position indicator, electrical cabinets, and stairs and landings for servicing) connected by oil lines. The development of a completely plant-ready hydraulic drive, i.e., a hydraulic drive which could be manufactured and tested at the plant and sent as a whole to the construction site in the form of a single ready-to-operate unit whose dimensions would allow it to be transported by railroad or motor transport, would be much more convenient. A hydraulic drive unit for operating one gate (individual), a hydraulic drive unit for operating two gates simultaneously, and a multipurpose universal hydraulic drive unit able to operate gates and lift and move heavy cargoes with a weight up to 1000 tons were developed. All components of the hydraulic drive, except the hydraulic cylinder, are installed from the service landing on the vertical frame, which is made of three separate parts and fastened to the hydraulic cylinder. Release of water through the structure are set and controlled by means of the gate position indicator. A new unit connecting the gate position indicator to the gate was added to the new design of the completely plant-ready hydraulic drive. Tests conducted at Mosgidrostal (USSR) completely confirmed the design premises for determining the discharge of water through the lower sealing component, selection of the cross section of the drain pipe, and performance of the proposed cable sealing component. Two types of designs were developed with respect to mode of transportation: a hydraulic drive in which the hydraulic cylinder is rigidly connected to the vertical frame and is placed in such a form on a platform car; and a hydraulic drive in which the hydraulic cylinder after plant tests can be easily disconnected from the vertical frame and is transported in such a form, and then at the installation site is easily connected into a single unit. (Fish-PTT)
W91-07638

COMPREHENSIVE EXPERT EVALUATION OF THE ECOLOGICAL CONSEQUENCES OF THE CONSTRUCTION OF HYDROPOWER FACILITIES.
For primary bibliographic entry see Field 8A.
W91-07876

ECOLOGICAL PROBLEMS OF THE THERMICS OF HYDROELECTRIC STATIONS.
For primary bibliographic entry see Field 5C.
W91-07878

NEW ESU-20 EJECTOR GROUNDWATER-LOWERING UNIT.
K. S. Bogolyubov, B. S. Krakovskii, L. A. Titov, A. D. Buntman, and E. A. Lokhanova.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 3, p 195-199, 1990. 3 fig, 2 tab, 5 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 3, p 28-30, March, 1990.

Descriptors: *Construction equipment, *Dewatering, *Groundwater level, *Hydraulic machinery, *Pumps, *Water level, Dam construction, Groundwater-lowering units, Performance evaluation, Pumped storage, USSR, Zagorsk.

Ejector wellpoint and downhole units are intended mainly for groundwater lowering in soils with permeability coefficients of 0.1-5.0/day (including conditions of water-bearing strata during construction) with required values of lower exceeding 7 m, measured from the ground surface. The only unit this type produced in quantity in the Soviet Union is the ejector wellpoint unit EI-70 being manufactured at the rate of 20-30 units per year. In 1986 work began on the design of the ESU-20 ejector groundwater-lowering unit intended for draining ground to a depth of 15-30 m. The ESU-20 unit

consists of a pumping station, pressurized distributing header, water-collecting header (operating in a pressurized or free-flow regime), and a set of U-shaped ejector water lifts installed in the wells on 48 mm-diameter pipes with flange connectors. Two ESU-20 units were manufactured and used to operate the drainage system at the Zagorsk pumped storage system (PSS); high effectiveness and reliability was shown. While this field test was in progress, continued laboratory studies showed that the introduction of a spiral, twisting flow of the working water, considerably increases the delivery of the water lift with respect to air and water-air mixture, practically changing nothing in the case of pumping out just water. The experience of operating the ESU-20 at the Zagorsk PSS showed that a useful addition to the design of the water lift to increase its reliability can be a check valve that will operate in the event of failure of the pumping station or clogging of the nozzle of the water lift and will eliminate leakage of the water into the ground. (Rochester-PTT)
W91-07882

RESULTS OF ACCEPTANCE TESTS OF THE PUMP-TURBINE OF THE KIEV PUMPED-STORAGE STATION.
L. Y. Margulis, E. D. Serebryannikov, and K. V. Uglikov.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 3, p 211-214, 1990. 4 tab. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 3, p 39-43, March, 1990.

Descriptors: *Hydroelectric plants, *Pump turbines, *Pumped storage, *USSR, *Upgrading, Design criteria, Hydraulic gates, Kiev Pumped Storage Station, Performance evaluation.

Modernization of the pump-turbine of the Kiev pumped-storage station (PSS) was carried out to improve the power and vibration characteristics of the units, provide their effectiveness during operation in a synchronous capacitor regime, and seal the gate apparatus. A new runner of type ORO 75 was installed as one of the steps to achieve these objectives. The modernized unit was subjected to full-scale tests under various operating regimes. The maximum active power of 43.2 MW was obtained at a head of 71.5 m, which corresponds to the operatic characteristic of the pump-turbine. Results were obtained for operation during a turbine regime and during load shedding tests, among others. It was concluded that, since the counterflow regime is accompanied by the most considerable dynamic loads on the unit, that it is desirable to reduce the duration of this regime. This can be accomplished by decreasing the time of closing of the gate apparatus. Overall, the modernized pump-turbine considerably surpasses the earlier design with qualitative indices and reliability and corresponds to the modern level of performance. (Rochester-PTT)
W91-07886

OPERATING STATE OF TURBINE-GENERATOR UNITS OF SMALL HYDROSTATIONS ACCORDING TO RESULTS OF VIBRATION STUDIES.
S. V. Bova, S. B. Neretin, and A. S. Dolgopolov.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 3, p 215-219, 1990. 4 fig, 1 tab, 3 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 3, p 43-45, March, 1990.

Descriptors: *Electrical equipment, *Turbines, *Hydroelectric plants, *Reliability, *USSR, *Vibrations, Abrasion, Maintenance, Monitoring, Pamir Region, Performance evaluation, Settling basins.

In the Pamir region of the Soviet Union, seven small hydroelectric power stations, with an installed capacity of 208 to 8700 kW are operating; in 1987 hydroelectric stations produced 73% of the total generation of electricity. Operating reliability at small hydrostations in remote regions can be a problem. Vibration studies were conducted at two stations in the Gorno-Badakhshan Autonomous region and the turbine-generator units were inspected to determine factors that might explain the results. Several inadequate procedures of operation and monitoring appeared to be responsible for vibration of the radial-thrust bearing at the Khorog hydrostation units Nos. 1 and 4 and the Namangut hydrostation units Nos. 1 and 2. Several recommendations are made based on this study: (1) to reduce abrasion of the turbine equipment, suspended particle settling basins should be provided; (2) specifications on the assembly of bearings and movable couplings should be developed for conducting maintenance work; (3) during restoration work, the profile of the runner blades should be made strictly according to the template in conformity with plant drawings; and (4) hydrostations should be equipped with a means of monitoring of important technical parameters (bearing temperature, water pressure in the passage, wobble of the shafting, etc.) so that problems can be detected and preventive maintenance carried out before a breakdown becomes likely. (Rochester-PTT)
W91-07887

PUMPED-STORAGE PROJECTS UNDER CONSTRUCTION IN JAPAN.
Electric Power Civil Engineering Association, Tokyo (Japan).
For primary bibliographic entry see Field 8A.
W91-07890

ROCKY MOUNTAIN PROJECT WILL PROVIDE PEAK POWER FOR GEORGIA.
Oglethorpe Power Corp., Tucker, GA.
For primary bibliographic entry see Field 8A.
W91-07891

DESIGN FEATURES OF THE MACHINERY FOR IMAICHI.
Toshiba Corp., Tokyo (Japan). Hydroelectric Engineering Dept.
F. Hoshino, and K. Ichikawa.
International Water Power and Dam Construction IWPCDM, Vol. 43, No. 2, p 26-28, February 1991. 2 tab.

Descriptors: *Hydroelectric plants, *Japan, *Pump turbines, *Pumped storage, Design criteria, Electrical equipment, Francis turbines, Imaichi Pumped Storage Plant, Performance evaluation.

In July 1988, the first of three units at the Imaichi pumped-storage plant (about 100 km N of Tokyo, Japan) began operation. The other two units are under construction. The equipment was developed specially by the Tokyo Electric Power Company and Toshiba, and it sets a number of records. The technical data of the pump-turbines are as follows: type, vertical shaft, Francis, reversible pump-turbines; rated effective head, 524 m; turbine output, 360 MW at rated head; rated speed, 429 rpm; maximum pumping head, 573 m; maximum pumping discharge, 59 cu m/sec (at minimum head of 528.4 m); specific speed, 30 m-cu m/sec (at minimum head); runaway speed, 630 rpm; and submergence, 70 m. Special attention was devoted to vibration control and runner stress measurement in the design of these pump-turbines. The generator-motors are vertical shaft, semi-umbrella, reversible and synchronous, with a totally enclosed air cooling circuit. The rated output is 390 MVA at 361 MW, rated voltage is 15,400 V, rated current is 14,620 A/14,620 A, rated frequency is 50 Hz, and rated power factor is 0.9/0.95. The first unit in this project has been operating successfully since 1988 and the second and third units are scheduled to commence commercial operation in December 1991. This project has established a better technological foundation for high-head, high-speed, and large-capacity equipment. (Rochester-PTT)
W91-07892

DEVELOPMENT OF A TWO-STAGE HIGH HEAD PUMP TURBINE.
Fluid Power Research Inst., San Francisco, CA.
A. Gokhman, and J. Carson.
International Water Power and Dam Construction IWPCDM, Vol. 43, No. 2, p 29-36, February 1991. 11 fig, 3 ref.

Descriptors: *France, *Hydraulic machinery, *Pump turbines, *Turbines, Comparison studies, Design criteria, Efficiency, Gokhman pump turbines, Hydraulic engineering, Performance evaluation, Truel-type turbines.

In an effort to develop pump-turbines suitable for high-head installations, two-stage pump turbines have been developed, notably at Le Truel (France, 38 MW at a head of 440 m) and by Hitachi (655 MW at a head of 1450 m). These designs, called here Truel-type pump-turbines, have various shortcomings, including a very large distance between the upper and lower bearings, inaccessibility of the lower bearings, and hydraulic losses in the return passage between the stages. In an effort to overcome some of these problems a new high-head, two-stage pump-turbine design was developed and was granted a United States patent in 1985. This machine, the Gokhman pump-turbine, can be constructed in either of two variants. The first has the capability in the turbine mode, whereas the second has the capacity to control it in both the turbine and pump modes. The Truel and Gokhman have been compared in terms of capabilities, maximum efficiency, Thoma cavitation coefficient, runaway throttling ratio, head distribution between stages, pulsations, shaft, lower bearing, vibrations, and weight of the machines. The analysis shows that the Gokhman pump-turbine has an advantage over the Truel-type machine in each of these areas except the value for submergence. The submergence required by the Gokhman pump-turbine is 58 m greater than that of the Truel-type machine (based only on the turbine mode operation consideration). It will require an additional length of penstock and low head conduit (connecting the draft tube with the lower reservoir), and additional excavation for these extensions. This disadvantage of the Gokhman machine could be offset by the savings in the wall thickness of the penstock (with a length of more than 1450 m), because of the higher value of the runaway throttling ratio. (Rochester-PTT)
W91-07893

OPERATING EXPERIENCE OF THE TUCURUI FRANCIS TURBINES.
Neyrpic, Grenoble (France).
J. A. A. Casagrande, M. Couston, and J. C. Diana.
International Water Power and Dam Construction IWPCDM, Vol. 43, No. 2, p 47-52, February 1991. 8 fig, 8 ref.

Descriptors: *Brazil, *Francis turbines, *Hydroelectric plants, *Turbines, Cavitation, Guidevanes, Hydraulic engineering, Performance evaluation, Safety, Tucurui Hydroelectric Plant.

The Tucurui (Brazil) Francis turbines are among the largest of their type in the world. Some of them have been operating more than 40,000 hr, indicating that they now can be considered to be a technical success. The main mechanical features of these turbines include: vertical shaft with two guide bearings; thrust bearing supported by the turbine headcover, with all loads transferred through the stayring to the concrete; runner and headcover removable through the generator stator opening; 26 guidevanes supported by two bearings above and below the water passage; guidevanes controlled by individual servomotors mechanically synchronized; and 26 servomotors located inside the headcover, which is an open structure. Each turbine is rated at 369 MW at 81.82 rpm with a possible overload discharge of 700 cu m/sec and a nominal head of 60.8 m; setting is -4.8 m below minimum tailwater. After initial installation, some design changes had to be made because synchronization of individually servo-driven guidevanes led to problems during commissioning. Since then, hydraulic behavior of the turbines has been investigated for 5 yr, covering performance, cavitation, stability, and stayvane and guidevane behavior. The first units have now been in continuous operation for more than 5 yr. Several hydraulic and mechanical tests have shown that the Tucurui turbines are running safely, efficiently, and almost without cavitation. (Rochester-PTT)
W91-07894

SOME CHARACTERISTICS OF CONSTRUCTING THE UNDERGROUND MACHINE HALL AT THE KOLYMA HYDROELECTRIC STATION.
For primary bibliographic entry see Field 8A.
W91-08031

UNDERGROUND PNEUMATIC SURGE TANKS OF HYDROELECTRIC STATIONS.
For primary bibliographic entry see Field 8A.
W91-08032

OBSERVATIONS OF UNLOADING OF THE WALLS OF THE UNDERGROUND MACHINE HALL OF THE HOA BINH HYDROELECTRIC STATION DURING CONSTRUCTION.
For primary bibliographic entry see Field 8E.
W91-08033

8D. Soil Mechanics

EFFECT OF WATER-CONTENT VARIABILITY IN DESIGN OF CLAY EMBANKMENTS.
Purdue Univ., Lafayette, IN. Dept. of Civil Engineering.
G. Agrawal, and A. G. Altschaeffl.
Journal of Geotechnical Engineering (ASCE) JGENDZ, Vol. 117, No. 4, p 673-683, April 1991. 3 fig, 6 tab, 11 ref.

Descriptors: *Earthworks, *Clay soils, *Embankments, *Soil engineering, *Moisture content, *Compacted soil, Indiana, Soil tests, Regression analysis, Compaction, Safety, Slope stability, Correlation analysis, Soil types, Economic aspects.

The design of earth structures must accommodate large variations in the magnitudes of the parameters that control the behavior of field-compacted soil. In practice, embankment design is governed by the values of these paramaters that can be guaranteed. This inherently large variability can thus result in ultraconservative designs because engineers must use 'worst-case' values. The compacted behavior of a number of typical Indiana soils was tested and the effect of water content variability on slope stability in the design of earth embankments was investigated. Conventional laboratory testing was carried out on samples taken in the field. Regression analyses were performed to obtain correlations between soil behavior parameter magnitudes and the field compaction variables for these soil types. The cases studied were randomly selected from among the various possibilities and reasonable parameter values were assumed. Decreased slope stability followed a pattern similar to that of decreased control of water content during compaction. The study indicated clearly that the range of water content values was the most important characteristic of earthworks relative to design cross section. Thus, more stringent control of the water content during compaction offers significant potential cost savings for clay embankment construction. (Doria-PTT)
W91-07395

EXPERIENCE IN USING THE VARIATIONAL METHOD IN SLOPE STABILITY CALCULATIONS.
V. N. Bukhartsev, A. Y. Ivanov, and I. Togo.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 4, p 281-284, 1990. 4 fig, 4 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 4, p 46-48, April, 1990.

Descriptors: *Building codes, *Hydraulic engineering, *Slope stability, *Soil mechanics, *Stability analysis, Foundation failure, Mathematical equations, Soil stability, Soil strength, Statistical analysis, USSR.

The USSR building codes recommend using a statistically founded method for estimating the stability of earth slopes within the framework of the nondeformation theory under two-dimensional conditions. This method is applicable for calculating stability with respect to an arbitrary surface of failure, not just a cylindrical surface, and, consequently, it can be used for determining the form of a dangerous failure surface. A method has been developed to describe the form of the failure surface by a piecewise linear function. This makes it possible to reduce the variational problem to the search for the ordinary extremum of a function of many variables. The middle part of the presumed sliding mass participating in the calculation, regardless of small variations of the failure surface, is divided into N-2 vertical elements of an arbitrary width. The widths of the elements must be assigned so that within the bottom of each element the soil strength parameters are constant. By virtue of continuity of the broken line approximating the directrix of the failure surface, N+2 unknowns are obtained, which are parameters of the strength function determining the factor of safety against sliding of the investigated soil mass. A singular system of nonlinear algebraic equations is easily solved by the iterative method with the use of a computer. If some information about the failure surface is suggested by the geological structure of the soil mass or design of the structure, for example, the start or end of the failure surface or its middle section is known, then in this case it is necessary to remove the equations corresponding to the known parameters from the system of equations. (Fish-PTT)
W91-07639

LIME-FLY ASH SLURRY PRESSURE INJECTION OF CLAY SOILS FOR LEVEE STABILIZATION.
Army Engineer District, Memphis, TN.
For primary bibliographic entry see Field 8G.
W91-07916

8E. Rock Mechanics and Geology

HIGH RESOLUTION AEROMAGNETIC SURVEY OF LAKE SUPERIOR.
Geological Survey of Canada, Ottawa (Ontario).
D. J. Teskey, M. D. Thomas, R. A. Gibb, S. D. Dods, and R. P. Kucks.
EOS EOSTAJ, Vol. 72, No. 8, p 81, 85-86, February 19, 1991. 5 fig, 20 ref.

Descriptors: *Aeromagnetic surveys, *Geologic mapping, *Geophysical exploration, *Geophysical surveys, *Great Lakes, *Lake Superior, *Magnetic studies, *Remote sensing, Canada, Data processing, Geologic fractures, Maps, Seismic properties, Seismic surveys.

A 57,000 line kilometer, high resolution aeromagnetic survey was flown in 1987 as a contribution to the Great Lakes International Multidisciplinary Program on Crustal Evolution (GLIMPCE). GLIMPCE was established in 1985 to study the nature and genesis of the crust in the Great Lakes region. In the Lake Superior area, a major objective of the program is to develop thermal, tectonic, and petrogenetic models for the evolution of the Midcontinent Rift system (MCR) and to evaluate these in the broader context of the tectonic evolution of the North American continent. Existing aeromagnetic data from the U.S. and Canada were combined with the new data to produce a composite map and gridded database of the Lake Superior region. Analysis of the new data permits more accurate definition of faults and contacts within the MCR. The aeromagnetic map provides important information supplemental to the seismic profiles acquired under the GLIMPCE program in 1986, allowing lateral extension of the seismic interpretation. Specifically, modeling of the data provides an independent assessment of a reflection seismic model derived along a survey line; the new magnetic data suggest modifications of some of the previously-defined fault positions, particularly the Isle Royale fault. Pre-1982 geological and geophysical knowledge of the MCR in the Lake Superior region has been summarized in past literature. The Lake Superior region provides a unique window on this Proterozoic rift system, exposing igneous rock of the Keweenawan Supergroup that disappears under Paleozoic cover to the southwest. (Fish-PTT)
W91-07615

ANALYSIS OF EXISTING APPROACHES WHEN EVALUATING THE ENGINEERING-GEOLOGICAL CONDITIONS OF TUNNEL CONSTRUCTION.
E. M. Pashkin.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 4, p 227-231, 1990. 3 fig, 4 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 4, p 9-12, April, 1990.

Descriptors: *Construction methods, *Geological data, *Geophysical surveys, *Hydraulic engineering, *Rock properties, *Tunnel construction, Geological surveys, Structural engineering, Tunnel failure, Tunnel linings, Tunneling, USSR.

The evaluation of the engineering-geological conditions of underground construction in deep horizons of rocks and prediction of the character and degree of their change during construction and operation of the structures is a complex problem. The most valuable information about possible changes in the state of the rocks at great depths as a result of interaction of the 'geological environment-underground structure' binary system can be obtained from the records made during past construction of tunnels of considerable length. The North Muya (USSR) railroad tunnel, with a length of 15.3 km, has become an instructive example for evaluating the importance of correct engineering-geological predictions when constructing tunnels. The erroneous interpretation of the complex geological information, obtained mainly by remote sensing methods, when developing engineering designs and the lax monitoring of the geological situation during construction of the tunnel led to a number of serious accidents. The construction of the Arpa-Sevan hydraulic tunnel, with a total length of 48.3 km, is an example of the complexity and sometimes impossibility of evaluating the engineering-geological conditions. Among the unsolved problems were: development of types of lining for rocks with different geotechnical properties and different magnitude of rock pressure; detection of zones of discharge of carbon dioxide and subsurface thermal waters with high flow rates; evaluation of the thermal conditions at depth; and evaluation of the possibility of rock failure in sections with considerable fracturing and zones of tectonic disturbances. At present it is rather difficult to predict complications encountered during tunneling and the time of their development because of the considerable uncertainties caused by the vertical direction and extremely low selectivity and limits of geological sampling along the tunnel route. The geological environment needs to be studied by advance multipurpose exploratory adits, advance exploratory boreholes, and geophysical sampling. (Fish-PTT)
W91-07629

NEW DESIGNS OF SUPPORTS FOR LARGE CHAMBER WORKINGS.
O. N. Zolotov, V. F. Ilyushin, and A. V. Kolichko.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 4, p 237-243, 1990. 6 fig, 8 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 4, p 16-20, April, 1990.

Descriptors: *Construction methods, *Deformation, *Hydraulic engineering, *Hydroelectric plants, *Load distribution, *Tunnel construction, Design criteria, Load testing, Rock bolts, Rock mechanics, Stress analysis, Structural engineering, USSR.

Two main trends in the area of support design for hydroelectric powerplant chamber works are the maximum use of the load-bearing capacity of the earth mass and the creation of designs having an increased deformability (yielding), satisfying the requirements of the calculated limit state imposed on them. Calculations of underground structures located in hard and soft rock masses weakened by joint systems should be carried out on the basis of physically nonlinear models taking into account not only the presence of the joints but also their structural characteristics (the characteristic distance between joints of each of these systems and their length). When constructing schemes of the

limit equilibrium of potentially unstable rock blocks, it is necessary to take into account the possible step character of their surfaces, which is a consequence of weakening of the rock mass by differently oriented joint systems. Movement of such blocks occurs in the direction of the slip surfaces of the step surface, determined by the dip angle of the shear-prone joint system. To support the roof of chamber workings located in masses characterized by a large value of horizontal tectonic stresses, it is necessary to use yielding load-bearing structural members. One of the possible effective designs is the yielding reinforced-concrete arch realized in the machine hall of the Rogun (USSR) hydrostation. When designing the wall bolting of large chamber works, it is expedient to take into account the load-bearing capacity of the rock-anchored arch forming around the works. (Fish-PTT)
W91-07632

DEFORMATION PROPERTIES OF ROCKS OF THE DIVERSION PRESSURE TUNNEL OF THE INGURI HYDROELECTRIC STATION.
G. K. Chumburidze.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 4, p 243-252, 1990. 8 fig, 2 tab, 9 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 4, p 20-26, April, 1990.

Descriptors: *Deformation, *Hydraulic engineering, *Hydroelectric plants, *Rock mechanics, *Rock properties, *Structural engineering, *Tunnel construction, Diversion structures, Geologic surveys, Geological formations, Geophysical surveys, Grouting, Tunnel linings, USSR.

The high-head Inguri (USSR) hydroelectric station has a diversion pressure tunnel with a length of 15.05 km and inside diameter of 9.5 m. The internal pressure along the length of the tunnel is 1.05-1.65 MPa, and its capacity is 450 cu m/sec. The depth of the tunnel is variable from 0 to 400-500 m, on average 200-250 m. This did not make it possible to conduct exploration by shaft and various drilling and auxiliary works. Therefore, the prediction of the engineering-geological conditions along the tunnel route at the design stage was based mainly on an engineering-geological survey at a scale of 1:25,000 and on experimental seepage flow works. During construction, detailed geological documentation established the character of anisotropy of the rock, thickness and direction of the beds, width of opening of joints and type of fillings, physical and mechanical properties of the rocks, tectonic structure of the region, fracture zones, fault zones, etc. It was especially important to establish the location and character of distribution of karst cavities, possible rock falls and cave-ins, as well as places of considerable water intrusion. Numerous rock samples recovered from boreholes in the form of cores were tested, and the following average characteristics of the rock were established: compressive strength 60-75 MPa, axial tensile strength 2.0-2.5 MPa, hardness on Mohs scale 4.5, density 2.5-2.6 g/cu cm, water absorption 5-6%, average modulus of elasticity 25,000 MPa. The effect of blanket grouting on a change in the deformation properties of the rock was investigated and it was shown that blanket grouting as a means of sealing the rock was most effective in a direction perpendicular to the bedding. Geophysical measurements made it possible to refine the design of the lining of the diversion tunnel in a number of its stretches. (Fish-PTT)
W91-07633

CONSIDERATION OF THE ANISOTROPIC PROPERTIES OF STRATIFIED ROCKS WHEN DESIGNING CRACK-RESISTANT LININGS OF PRESSURE TUNNELS.
G. K. Chumburidze, and S. G. Safarova.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 4, p 252-259, 1990. 5 fig, 1 tab, 9 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 4, p 26-31, April, 1990.

Descriptors: *Anisotropy, *Hydraulic engineering, *Rock mechanics, *Rock properties, *Stress analysis, *Tunnel construction, *Tunnel linings, Building codes, Deformation, Elastic properties, Linings, USSR.

The static methods of constructing the linings of pressure tunnels recommended by USSR building codes are based on the assumption that the rocks surrounding a tunnel are elastic, isotropic, and homogeneous. However, there are no recommendations on selecting the necessary method of calculation. An analysis of various theoretical solutions with respect to consideration of the effect of anisotropy on the stress state of pressure tunnel linings showed that the calculation method where the effect of tangential forces of interaction along the contact of the lining with the rock is taken into account is the most accurate one satisfying the static conditions of the construction of linings in stratified rocks. To investigate the effect of anisotropic properties of rock on the stress-strain state of crack-resistant circular linings of pressure tunnels, two examples of calculations with various combinations of the tunnel diameter, internal water pressure, and ratio of the moduli of elasticity of concrete, and deformation of rock were examined. In the investigated examples, calculations of a lining in an isotropic medium were calculated initially with a minimum value of the modulus of deformation for the purpose of comparison. As a result of assigning higher values to the modulus of deformation along the x-axis, the anisotropy coefficient reaches 2.5, and the character of the distribution of the stresses over the lining sections changes. Thus, the values of the edge tensile stresses in both examples decrease in mutually perpendicular directions, but in all cases in a direction coinciding with the bedding, the lining sections are more stressed than the sections oriented across the bedding. The substantial decrease of the tensile stresses in the lining in the second example in comparison with the first is explained by the effect of a more rigid lining, which takes on a greater part of the load from the internal pressure, and thereby unloads the lining. It is recommended that the unknown values of the elastic characteristics of rock be determined on the basis of the relationships of an anisotropic stratified medium by setting up and solving the appropriate system of equations. (Fish-PTT)
W91-07634

IMPROVEMENT OF METHODS OF CALCULATING THE OPTIMAL PARAMETERS OF SMOOTH-WALL BLASTING.
For primary bibliographic entry see Field 8H.
W91-07635

ENGINEERING MODEL OF DEFORMATION AND FRACTURE OF ROCKS AND CONCRETE UNDER COMPRESSION.
M. G. Zertsalov.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 4, p 263-270, 1990. 5 fig, 1 tab, 17 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 4, p 33-37, April, 1990.

Descriptors: *Concrete technology, *Hydraulic engineering, *Mechanical failure, *Rock mechanics, *Stress-strain curves, *Structural engineering, Compressive strength, Concrete, Deformation, Mathematical analysis, Model testing, Rock properties, Shear stress, Stress analysis, Tensile stress, USSR.

Study of the deformation and fracture of rocks and concrete under compression is necessary for application to construction of large hydroelectric power structures. Experimental investigations show that microcracking, caused by breaking of or between individual rock grains, begins in rocks and concrete under stresses corresponding to the start of the third segment of the compressive stress curve. The use of a model of a medium weakened by a large number of fine elliptical cracks for describing the deformation of blocks and concrete within limits of the first and second segments of the compressive stress curve, i.e., before the start of the process of microcracking, was examined. A fragment having a three-member cut containing the initial shear crack and two curved tension cracks in a biaxial compressive stress field was investigated experimentally. Both the initial crack and the branched cracks were modeled by special contact elements. Numerical experiments on the basis of their design with the use of mathematical statistical methods established a factor dependence, in which the response functions were the movements in the direction of action of the principal stresses. Not in a single one of the calculations does the length of the tension cracks exceed the length of the initial shear crack and their paths do not propagate beyond the limits of the curved sections, indicating an insignificant mutual effect of cracks during microcracking. The given data indicate that under stresses close to the peak one, an increase of inelastic deformations in comparison with their values after the start of microcracking was proportional to the increase of the volume of microcracks, and this is possible if the mutual effects of the cracks is displayed insignificantly. A comparison of the results of theoretical and experimental investigations shows that the curves plotted analytically agree sufficiently satisfactorily (10-20%) with the experimental data. (Fish-PTT)
W91-07636

NUMERICAL MODELING OF A FRACTURED ROCK MASS AROUND UNDERGROUND WORKINGS.
O. N. Zolotov.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 3, p 178-185, 1990. 5 fig, 1 tab, 7 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 3, p 18-22, March, 1990.

Descriptors: *Deformation, *Geologic fractures, *Method of initial stresses, *Model studies, *Rock excavation, *Rock mechanics, Construction methods, Creep, Mathematical models, Numerical models, Stress analysis, Underground structures.

When excavating underground workings, the development of inelastic deformations accompanied by such complex rheological phenomena as plasticity, creep, etc., is observed in the contour region of the enclosing mass. The intensity of this process is determined largely by the structure and degree of fracturing of the rocks. Mathematical modeling of this process for various rock media on the basis of universal numerical methods is the quickest and most economical way to obtain the necessary predictions of changes in the natural state of the mass caused by driving a working. The method of initial stresses (MIS) is finding wide use when solving such problems. The numerical scheme of MIS is developed in modeling the step character of load application and consideration of changes in the strength and properties of the medium. An analysis of the results of calculations and parameters of the computation process for nonlinear problem solving demonstrates that, in the case of a single working without support, being excavated in full section, it is necessary to use only the classical scheme of the MIS with an accuracy sufficient for design practice. (Rochester-PTT)
W91-07880

ENGINEERING MODEL OF DEFORMATION AND FAILURE OF ROCKS AND CONCRETE UNDER COMPRESSION.
M. G. Zersalov.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 3, p 185-194, 1990. 5 fig, 13 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 3, p 22-27, March, 1990.

Descriptors: *Compressibility, *Concrete technology, *Deformation, *Mechanical failure, *Model studies, *Rock mechanics, Cracks, Finite element method, Geologic fractures, Mathematical equations, Numerical analysis, Stress-strain curves.

Numerical methods, mainly the finite element method, are used when calculating the interaction of a rock mass with concrete structures. The stress-strain state of the rock mass-structure system is determined in most cases with consideration of the fact that the rock is modeled by a homogeneous isotropic (or anisotropic) elastic or elastoplastic solid medium. An engineering model is examined of deformation of rocks and concretes under conditions of uniform compression within the first and second segments, that is, up to the start of microcracking. The initial medium is one weakened by a large number of fine elliptical cracks. In the case investigated it is assumed that the stresses applied

to the boundary of a volume element with a crack are homogeneous and equal to the stresses on the outer boundary of the entire body. Each crack is characterized by an angle of a slope at a certain angle to the direction of maximum compressive stress and has a predictable length. The distribution with respect to angles is isotropic. The case of biaxial stress is examined initially and ultimately an expression is obtained for the effective modulus under conditions of uniaxial stress. Curves of the dependence of stresses on longitudinal and transverse strains for rocks and concrete under conditions of complex loading in the case of deformation of these material up to the start of microcracking can be plotted using the equations of state developed here. (Rochester-PTT)
W91-07881

ENGINEERING MODEL OF DEFORMATION AND FRACTURE OF ROCKS AND CONCRETE UNDER COMPRESSION.
M. G. Zertsalov.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 5, p 291-297, 1990. 4 fig, 3 tab, 14 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 5, p 16-19, May, 1990.

Descriptors: *Concrete, *Concrete technology, *Construction materials, *Engineering geology, *Geologic fractures, *Materials engineering, *Rock mechanics, Compression, Compressive strength, Deformation, Microfractures, Model studies, Stress analysis.

An alternative approach to formulation of the criterion of microfracturing is proposed, which is formulated on the basis of analyzing the results of a number of experimental investigations of rock and concrete specimens under conditions of uniaxial and combined stress states. Investigations have indicated that compressive pressure does not significantly affect the change in volume due to microfracturing. Inelastic lateral deformation of specimens is directly proportional to the volume of microfractures and hence to their density. In general, the peak strength was reached when decompression of the specimen material caused by microfracturing reached a certain critical value. An idealized diagram of behavior of rocks and concretes under uniaxial and multiaxial compression is proposed. The slope angle of the beyond-limit curve in the idealized diagram can be determined from uniaxial compression tests. If such data are absent, then as a first approximation the beyond-limit curve can be approximated by a linear relation and can be assumed to be symmetrical with the before-limit stress-strain curve. (MacKeen-PTT)
W91-08028

OBSERVATIONS OF UNLOADING OF THE WALLS OF THE UNDERGROUND MACHINE HALL OF THE HOA BINH HYDROELECTRIC STATION DURING CONSTRUCTION.
M. G. Ezerskii, S. I. Skiba, and S. A. Bryukhov.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 5, p 319-323, 1990. 3 fig, 3 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 5, p 34-37, May, 1990.

Descriptors: *Construction, *Deformation, *Hydroelectric plants, *Rock excavation, *Rock mechanics, *Underground structures, Engineering, Geological data, Hoa Binh Hydrostation, Hydraulic machinery, Stress analysis, Vietnam.

The machine hall of the Hoa Binh hydro development in Viet Nam being constructed by the underground method in extrusive rocks, is a structure unique in design with a length of 260 m, width of 20 m, and height of 57 m from the bottom of the construction pit to the crown of the arch. Observations in intensely excavated sections of the machine hall were carried out 1-2 times per month, and readings of the control roof bolts were taken weekly. Gradation of the deformation state of the rocks was achieved by ultrasonic measurements of the propagation velocities of longitudinal and transverse waves in deep parts of the mass. Data indicated the following general features of unloading of the mass during construction and the first 6 mo of start-up: over the entire length of the inter-chamber pillar there was a decrease of up to 30% in the wave velocities with time; the unloading process developed more intensely in the central part of the pillar and less intensely near the arch; and unloading lasted through the entire period of excavation and continued for an average of 3-4 mo until stabilization of the deformations occurred. The observations confirmed the decompression of the entire body of the inter-chamber pillar and the effectiveness of using pre-stressed roof bolts. (MacKeen-PTT)
W91-08033

GEOLOGY AND GROUND-WATER RESOURCES OF THE COASTAL AREA OF GEORGIA.
Geological Survey, Atlanta, GA. Water Resources Div.
For primary bibliographic entry see Field 2F.
W91-08187

8F. Concrete

ANCHOR EMBEDMENT IN HARDENED CONCRETE UNDER SUBMERGED CONDITIONS.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Structures Lab.
For primary bibliographic entry see Field 8G.
W91-07215

ENGINEERING MODEL OF DEFORMATION AND FRACTURE OF ROCKS AND CONCRETE UNDER COMPRESSION.
For primary bibliographic entry see Field 8E.
W91-07636

ENGINEERING MODEL OF DEFORMATION AND FAILURE OF ROCKS AND CONCRETE UNDER COMPRESSION.
For primary bibliographic entry see Field 8E.
W91-07881

CONCERNING THE PROBLEM OF CHECKING THE STRENGTH OF HYDROTECHNICAL CONCRETE.
S. I. Semenenok.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 3, p 206-210, 1990. 2 fig, 4 tab, 5 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 3, p 35-37, March, 1990.

Descriptors: *Concrete construction, *Concrete testing, *Standards, *Strength, *Testing procedures, *USSR, Bolomei formula, Concrete technology, Martin method, Mathematical formulas, Water-cement ratio.

Checking the average level of strength of hydrotechnical concrete under Soviet State Standard GOST 27006-86 can be problematical. Methods of making such a statistical evaluation have been reviewed and analyzed. Underlying practically all recommendations and methods of selecting (calculating) concrete compositions is the Bolomei formula, which determines the dependence of strength on the water/cement (W/C) factor. In essence, the entire complex of technological measures on increasing the homogeneity of concrete reduces to stabilization of the water content of the concrete mix, stability of the W/C factor for a given fluidity. Studies of several days of batches of concrete showed that the daily coefficient of variation of W/C averaged 7%. Hydrotechnical construction is distinguished by a considerable diversity of situations in which it is difficult to fulfill the rules of batch checking. One alternative method is that of Martin, published in Spain in 1971. In this method, a parameter representing relative minimum strength with 95% probability for 18 of fewer individual strength tests. The reliability of this estimate is not randomly limited to a 95% probability. In certain cases it makes sense to use Martin's method in a batch checking system for massive structures in hydrotechnical construction, especially when evaluating individually taken groups, batches, and certain zones of concrete with a high service life or increased requirements with respect to homogeneity. (Rochester-PTT)
W91-07885

EVALUATION OF THE STRENGTH OF REINFORCED-CONCRETE MEMBERS ON THE BASIS OF SECONDARY STRESS FIELDS.
A. S. Zalesov, and S. E. Lisichkin.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 3, p 221-226, 1990. 3 fig, 16 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 3, p 46-49, March, 1990.

Descriptors: *Concrete testing, *Cracks, *Dam safety, *Reinforced concrete, *Strength, *Stress analysis, Concrete technology, Construction joints, Standards, Stress fields, Structural engineering, Testing procedures.

The current standards for dam safety do not take into account the possible formation and intense development along the longitudinal concreting block joint of secondary cracks separating the structural member and the transformation of initial stresses into a secondary stress field accompanying such a phenomenon. Further improvement of the method of calculating transverse reinforcement for increasing the reliability of members weakened by longitudinal block joints required a more thorough consideration of the characteristics of the behavior of the transverse reinforcing bars in the zone of their intersection by the block joint. Analysis of this problem led to some suggestions for calculating the strength of concrete joints with transverse reinforcements based on using the method of secondary stress fields. This also permits more complete consideration of the effect of the characteristics of the stress state on the strength of massive members. The suggestions offered here make it possible to evaluate the reinforcement and concrete strength of the structural member being designed with pin resistance of the transverse bar reinforcement to the effect of the initial and secondary shear stresses in the longitudinal joint. The installation of an additional amount of transverse reinforcement precludes the probability of separation of the massive member along the longitudinal block joint and provides reliable and safe operation of the structure. (Rochester-PTT)
W91-07888

UNDERWATER--QUICK SET AND CEMENT GROUTING, AN INNOVATIVE METHOD TO REHABILITATE MILWAUKEE HARBOR BREAKWATER.
Army Engineer District, Detroit, MI.
For primary bibliographic entry see Field 8G.
W91-07915

ENGINEERING MODEL OF DEFORMATION AND FRACTURE OF ROCKS AND CONCRETE UNDER COMPRESSION.
For primary bibliographic entry see Field 8E.
W91-08028

METHODS OF CALCULATING MASSIVE REINFORCED-CONCRETE MEMBERS AND HYDRAULIC STRUCTURES.
V. B. Nikolaev.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 5, p 300-304, 1990. 4 fig, 11 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 5, p 21-24, May, 1990.

Descriptors: *Concrete construction, *Concrete technology, *Concretes, *Reinforced concrete, *Strength, *Structural engineering, Cracks, Hydraulic structures, Massive members, Mathematical analysis, Mechanical failure, Stress.

An analysis of the pattern of cracking of massive members showed that cracks in massive members should not be assumed to be linear but should be approximated by three or four segments. Of decisive importance is a determination of the stress state of the pre-failure crack. Taking the development of cracks on area elements of action of the

principal stresses and making a number of assumptions, an expression for the angle of inclination of the crack was obtained. Testing of the developed method was carried out by numerical and experimental methods in lightly reinforced beam members and fragments. In all, more than 100 reinforced concrete models of different scale were tested for the effect of the angle of inclination of the crack on the strength of the members. It is concluded that the method is reliable, with a safely factor of within 10%. Calculation of a reinforced concrete mass structure, such as a hydrostation powerhouse and pumping station, is carried out by numerical methods according to a two-dimensional reduced or three-dimensional scheme. The theoretical apparatus makes it possible to reliably carry out reinforcing of massive complex three-dimensional structures. (MacKeen-PTT)
W91-08030

OPTIMIZATION OF THE FORM OF A CONCRETE ARCH DAM.
Y. V. Kirillov.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 5, p 338-346, 1990. 6 fig, 2 tab, 4 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 5, p 47-52, May, 1990.

Descriptors: *Computer models, *Concrete dams, *Dam design, *Dams, *Optimization, Algorithms, Arch dams, Compression, Concrete technology, Design criteria, Structural engineering, Tensile stress.

An algorithm was developed for finding the optimal form of concrete arch dams using the method of local variations for minimizing the volume of concrete and penalty function taking into account the conditions of the strength of the material and structural constraints. On the basis of the algorithm developed, a universal software package, OPTAR, was created for solving problems of optimizing concrete arch dams, making it possible to obtain an accuracy acceptable from the engineering viewpoint with moderate expenditures of computer time. The problem of optimizing a concrete arch dam at a rectangular site was solved by means of the OPTAR software. The results made possible a 40% reduction of the volume of concrete compared with the initial design. The optimal design is remarkably underloaded with respect to compression. The tensile stresses at the root zone of the crown cantilever on the upstream face are the main limiting factors. It is therefore expedient to use zoning of concrete and to consider the possibility of increasing the degree of use of the concrete strength by using dams with various joints to increase the radial displacements of the dam crest and reduce the concentration of cantilever stresses. Further testing of the method is recommended. (MacKeen-PTT)
W91-08037

8G. Materials

RECOMMENDED PRACTICES FOR TESTING WATER-PUMPING WINDMILLS.
DHV Consulting Engineers, Amersfoort (Netherlands).
For primary bibliographic entry see Field 8C.
W91-07201

ANCHOR EMBEDMENT IN HARDENED CONCRETE UNDER SUBMERGED CONDITIONS.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Structures Lab.
J. E. McDonald.
Available from the National Technical Information Service, Springfield, VA 22161. Technical Report REMR-CS-33, October 1990. Final Report. 38 p, 24 fig, 5 ref.

Descriptors: *Adhesives, *Anchors, *Concrete, *Marine environment, *Materials testing, Resins, Strength, Tensile strength, Vinylester.

Anchors embedded in hardened concrete under submerged conditions with prepackaged adhesive capsules exhibit significant reductions in tensile load capacity compared to anchors installed under dry conditions. This relatively poor performance of anchors with embedment lengths up to 24 inches is the result of water in the drill hole mixing with adhesive. Although insertion of the adhesive capsule or cartridge into a submerged drill hole will displace the majority of the water in the hole, water will remain between the walls of the adhesive container and the drill hole. Insertion of the anchor traps this water in the drill hole and causes it to become mixed with the adhesive. An anchor installation procedure that eliminates the problem of resin and water mixing in the drill hole is described. Basically this procedure uses resin in both bulk and capsule form to displace the water in a drill hole prior to anchor insertion and spinning. Pullout tests on vertical and horizontal anchors embedded in vinylester resin with this revised installation procedure resulted in tensile capacities near the yield load of the anchors for both dry and submerged installations. Test to date on anchors installed with the revised procedure have been limited to short-duration loadings at relatively early ages. Additional testing should be conducted to determine the long-term performance of vinylester resin under wet, alkaline conditions. Also, creep tests should be conducted to evaluate the effect of sustained loads on anchors installed with the revised procedure. The potential for eliminating the resin capsule and injecting all of the adhesive in bulk should also be investigated. (Author's abstract)
W91-07215

PERFORMANCE OF AUSTENITIC STAINLESS STEELS IN MSF DESALINATION PLANT FLASH CHAMBERS IN THE ARABIAN GULF.
University of Petroleum and Minerals, Dhahran (Saudi Arabia). Research Inst.
For primary bibliographic entry see Field 3A.
W91-07384

CALCIUM CARBONATE SCALE FORMATION AND PREVENTION IN A FLOW-THROUGH SYSTEM AT VARIOUS TEMPERATURES.
Patras Univ. (Greece). Dept. of Chemistry.
For primary bibliographic entry see Field 3A.
W91-07389

NEW NUMERICAL/PHYSICAL FRAMEWORK FOR MOBILE-BED MODELLING: PART 2--TEST APPLICATIONS.
Iowa Univ., Iowa City.
For primary bibliographic entry see Field 2J.
W91-07597

PRECAST PLIANT LINING FOR DIFFICULT GEOLOGICAL CONDITIONS.
A. A. Simonyan, and P. S. Oganesyan.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 4, p 231-233, 1990. 3 fig. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 4, p 13-14, April, 1990.

Descriptors: *Geologic formations, *Hydraulic engineering, *Materials engineering, *Plastics, *Tunnel construction, *Tunnel linings, Compressive strength, Construction methods, Linings, Load testing, Materials testing, Model testing, Plasticity, Polymers, Rock mechanics, Stress analysis, USSR.

The experience of tunnel construction at great depth shows that the character of deformation of the surrounding rock mass qualitatively changes with increase in depth. At great depths construction causes creep and ultimately leads to large displacements of the rocks. This same circumstance causes deformation of the lining. Therefore, it makes sense to use linings having a certain pliancy and sufficient strength. It is possible to use foamed plastics, which have good deformation and strength characteristics. An analysis of the physical, mechanical, and economic indices of foam plastics showed that the most suitable material for the pliant layer is PSB-S polystyrene foam plastic with an apparent density of 30 kg/cu m. Stress-strain diagrams show that, under compressive loads, considerable deformation of the foam plastic without the loss of load-bearing capacity is observed. Of main interest is the region of flow, where the polystyrene foam under a load of 0.13 MPa begins to be deformed under insignificant changes in the stresses, i.e. as a result of large displacements of the rocks of the contour of the working, the load on the lining increases a small amount. An experimental model tested, in a scale of 1:20, the lining of ring forms with an outside diameter of up to 7 m. A certain nonuniformly-distributed loading pattern was set on plaster blocks with an average radius of 10.25 cm and the stresses at the joints were determined. Then the same loading pattern was set on this same structure but stress-tested with different groups of elements (blocks) of polystyrene foam with a thickness of 0.5, 1, 1.5, and 2 cm. Similar investigations were carried out for various loading patterns. Tests on structures with average radii of 11.5 and 12.75 cm were carried out in the same sequence. It was found that with an increase of the thickness of the pliant layer, a more pronounced equalization of the stresses in the joints and, consequently, of the loads on the structure occurs. The proposed structure of the lining is recommended for supporting tunnels being driven under conditions of a large rock pressure. (Fish-PTT)
W91-07630

POSSIBLE RE-USE OF PETROLEUM CONTAMINATED SOILS AS CONSTRUCTION MATERIAL.
Lehigh Univ., Bethlehem, PA. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5E.
W91-07674

STABILIZATION OF CLASS F FLY ASH WITH LIME AND CEMENT.
Wayne State Univ., Detroit, MI. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5E.
W91-07675

TEST METHODS FOR THE EVALUATION OF TREATED SLUDGES FOR CONSTRUCTION PURPOSES.
Drexel Univ., Philadelphia, PA. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5E.
W91-07679

ENGINEERING MODEL OF DEFORMATION AND FAILURE OF ROCKS AND CONCRETE UNDER COMPRESSION.
For primary bibliographic entry see Field 8E.
W91-07881

MEASUREMENT OF UPPER POOL LEVELS OF A HIGH DAM DURING CONSTRUCTION.
For primary bibliographic entry see Field 8A.
W91-07883

EFFECTIVE CORROSION PROTECTION AND WATERPROOFING OF THE BUSBAR SHAFTS OF THE INGURI HYDROSTATION POWERHOUSE.
U. I. Godzhiashvili, I. I. Maisuradze, M. N. Chaava, and G. A. Beburishvili.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 3, p 204-205, 1990. 1 fig, 3 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 3, p 34, March, 1990.

Descriptors: *Corrosion control, *Hydroelectric plants, *Materials engineering, *Metals, *USSR, *Waterproofing, Asphalt, Busbar shafts, Epoxy resins, Inguri Hydrostation, Mastics, Powerhouses.

Corrosion causes losses equal 10% of the volume of metal being manufactured. To reduce losses and increase the life of structures, corrosion protection problems should be solve as early as the design stage so that structural elements with their main protective coatings applied under factory condi-

tions can be used. Intense corrosion of metal at the Inguri hydrostation underground powerhouse (Soviet Georgia) necessitated special investigations of the causes of corrosion and the development of protective measures. A waterproofing mastic, developed by the Georgian Scientific Research Institute of Power Engineering and Hydraulic Structures, and consisting of a composition of road asphalt emulsified in water in the presence of a solid emulsifier (slaked lime or light and heavy clays, asbestos flour, etc.), was proposed for treating the structure. After preparing the paste, epoxy resin with a hardener and organic solvent (e.g., benzene, toluene, xylene, ethylene dichloride) are added to the composition. After cleaning the metal surface to be treated with metal brushes, the mastic is applied with paint brushes and putty knives. A favorable property of the mastic is that it is applied on both a dry and wet base. This mastic permitted extremely rapid halting of corrosion in the busbar shafts of the Inguri underground powerhouse. Repetition of the treatment every 10-15 yr is recommended for reliable protection of structures. (Rochester-PTT)
W91-07884

CONCERNING THE PROBLEM OF CHECKING THE STRENGTH OF HYDROTECHNICAL CONCRETE.
For primary bibliographic entry see Field 8F.
W91-07885

RESULTS OF ACCEPTANCE TESTS OF THE PUMP-TURBINE OF THE KIEV PUMPED-STORAGE STATION.
For primary bibliographic entry see Field 8C.
W91-07886

EVALUATION OF THE STRENGTH OF REINFORCED-CONCRETE MEMBERS ON THE BASIS OF SECONDARY STRESS FIELDS.
For primary bibliographic entry see Field 8F.
W91-07888

UNDERWATER--QUICK SET AND CEMENT GROUTING, AN INNOVATIVE METHOD TO REHABILITATE MILWAUKEE HARBOR BREAKWATER.
Army Engineer District, Detroit, MI.
R. L. Erickson, W. A. Rito, and T. A. Deja.
Army Repair, Evaluation, Maintenance, and Rehabilitation Research Program Information Exchange Bulletin, Vol. 7, No. 2, July 1990. p 1-6, 3 fig.

Descriptors: *Cements, *Grouting, *Milwaukee Harbor Breakwater, Concrete, Maintenance, Materials testing, Milwaukee Harbor, Wisconsin.

The Milwaukee Harbor, Wisconsin, project, was originally authorized under seven River and Harbor Acts from 1852 to 1962. The breakwaters, which were constructed between 1882 and 1899, consisted of a timber cribbing substructure filled with 'man-sized' stone; most of the cribs were founded on crushed stone. Concrete superstructures (caps and foot blocks) were added between 1903 and 1909. Partial loss of the stone fill reduced support for the concrete caps, resulting in settlement of the caps, cracking and outward bending of the steel sheet piling, and breaking of the tie rods. More of the smaller, interior stone fill, exposed to waves, washed out. To protect the failing steep sheet piling, armor stone was placed along the face of the structure. Left unchecked, the structure was bound to fail, exposing the harbor features. Several types of repair were evaluated for the rehabilitation of the Milwaukee Breakwater; however, the method finally chosen was to grout the interior of the structure. This method would: resupport the concrete cap and prevent future settlement; prohibit additional loss of the stone fill; and, add weight to the structure to once again make it stable and resistant to overturning and sliding. The quick-set grouting and sand-cement grouting of Milwaukee was completed with little difficulty. The major concern was whether the grouts were resupporting the breakwater caps. To check the grout after placement, a series of twenty, 4-in.-diameter cores was drilled. The cores were taken through the cap and grouts into the underlying stone fill. Inspection of the cores revealed the sand-cement grout was very competent, and, in most cases, the grout was bonded to the bottom of the concrete cap. The contract for grouting at Milwaukee was completed in August 1988. The final project consisted of drilling 27,873 linear ft of grout holes, placing 2,900 cu yd of quick-set grout, and 8,250 cu yd of sand-cement grout. (Lantz-PTT)
W91-07915

LIME-FLY ASH SLURRY PRESSURE INJECTION OF CLAY SOILS FOR LEVEE STABILIZATION.
Army Engineer District, Memphis, TN.
D. Abernathy, and M. J. Stegall.
Army Repair, Evaluation, Maintenance, and Rehabilitation Research Program Information Exchange Bulletin, Vol. 7, No. 2, July 1990. p 7-9, 3 fig.

Descriptors: *Fly ash, *Lime, *Slurries, *Soil stabilization, Injection, Landslides, Levees, Mississippi River, Missouri, Slope stabilization, Soil pressure.

In January 1988 a levee slide was reported in the Main Line levee of the Mississippi River near Point Pleasant, Missouri. During the initial site visit, two distinct slides along the riverside slope were identified. The smaller slide was fully contained within the riverside slope and had the familiar stair-step appearance associated with surficial slides in high-plasticity clays. The larger slide encompassed the entire levee crown width as well as the riverside slope, yet did not exhibit the stair-step geometry. For this reason, a detailed geotechnical analysis was performed on that slide to determine the failure mechanism. The analysis confirmed the development of residual shear strengths along the failure plane. This plane was relatively deep and generally ran parallel to the interface of the levee base with natural ground for that portion beneath the riverside slope. The average plasticity index within the failed mass was 50, and residual strength values varied from a phi of 12.5 to 14.0 degrees depending on the assumptions made regarding tension cracks and the presence of water. A technique known as lime-fly ash slurry pressure injection (LFASPI) was used on the entire levee reach (approximately 2.8 miles) in 1988. The LFASPI method consists of creating a cementitious mixture of lime and fly ash and injecting it into the soil. The construction sequence specified for LFASPI at the Point Pleasant, Missouri, site was as follows: (1) remove and stockpile topsoil and gravel surfacing; (2) restore levee section, and semicompact work surface to make a smooth and stable platform; (3) make primary injections in swaths perpendicular to the levee centerline, leaving 5-ft spacing between holes and allowing a minimum cure time of 48 hr; (4) repeat Step 2 if movement occurs during primary injections; (5) make secondary injections diagonal to primary holes; (6) disc and semicompact outer 6 inches to incorporate excess slurry into soil; (7) replace topsoil and gravel surfacing; and (8) fertilize and overseed levee slope. Although the effectiveness of LFASPI in slope repair on this project may not be known for several years, similar repairs in the Kansas City District have shown some longitudinal cracking, but has had no additional sliding since the October 1988 completion. (Lantz-PTT)
W91-07916

METHODS OF CALCULATING MASSIVE REINFORCED-CONCRETE MEMBERS AND HYDRAULIC STRUCTURES.
For primary bibliographic entry see Field 8F.
W91-08030

8H. Rapid Excavation

IMPROVEMENT OF METHODS OF CALCULATING THE OPTIMAL PARAMETERS OF SMOOTH-WALL BLASTING.
V. A. Fokin, and G. N. Sirotyuk.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 4, p 259-262, 1990. 4 fig, 2 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 4, p 31-32, April, 1990.

Descriptors: *Construction methods, *Explosions, *Hydraulic engineering, *Rock excavation, *Rock mechanics, *Tunnel construction, Explosives, Geologic formations, Hydraulic roughness, Hydroelectric plants, Rock properties, USSR.

The use of the smooth-wall blasting method, to increase the stability of the works, can substantially help to increase the efficiency and quality of driving underground works during construction of large hydroelectric structures. A more detailed analysis of experimental data was necessary to reveal regularities not dependent on the blasting conditions and to develop methods of calculating the optimal parameters of smooth (contour) breaking with a given degree of smoothness of the surface of the works. A methodological approach has been developed to solve this problem. A minimum index of reduced relative roughness equal to 0.26 m/kg is used as the main index, making it possible to optimize the parameters of smooth-wall blasting. The following requirements providing a prescribed effectiveness of contouring of the works were used when developing the calculation method: the powder factor for the contour row corresponds to the energy expenditures on breaking the near-contour rock layer characteristic for the given geological and mining conditions; the parameters of the zone of breaking the near-contour layer are determined by the equality of the specific energy transmitted to the rock upon detonation of the charges (with consideration of their interaction) and specific work of brittle fracture of the rock along the break line. The proposed complex index (reduced relative roughness), characterizing the maximum degree of smoothness of the surface of the works with appropriate energy expenditures on its formation, meets the requirements of the technological criterion of optimality of smooth-wall blasting parameters. The optimal value of the burden-to-charge spacing ratio is determined only by the relationship between the diameters of the blasthole and of the charge located in it. The absolute values of the parameters of the arrangement of the blastholes should be determined on the basis of the established optimal burden-to-charge spacing ratio and value of the powder factor for breaking the near-contour rock layer. The proposed method provides a method for estimating expected quality of contouring the works for given mining conditions. (Fish-PTT)
W91-07635

NUMERICAL MODELING OF A FRACTURED ROCK MASS AROUND UNDERGROUND WORKINGS.
For primary bibliographic entry see Field 8E.
W91-07880

LARGE-SCALE EXPERIMENTAL BLASTING ON THE UCH-TEREK RIVER.
N. V. Dmitriev, M. B. Etkin, and V. I. Vasil'chenko.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 5, p 285-291, 1990. 6 fig, 1 tab. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 5, p 12-15, May, 1990.

Descriptors: *Dam construction, *Explosions, *Explosives, *Rapid excavation, *Rock excavation, *Uch-Terek River, Earth dams, Rivers, Rockfill dams, Toktogul Region, USSR, Water resources development.

Experimental large-scale blasting was carried out on the Uch-Terek River as part of development of the Toktogul region. A narrow U-shaped canyon of the Uch-Terek River was selected as the site of conducting large-scale blasting. The canyon slopes are steep (35-45 degrees) and high (up to 200 m). The wall masses are represented by a suite of sandstone and siltstones. The density of the soils is 2600 kgf/cu m and the compressive strength is 70-80 MPa. The binary mixture ammonium nitrate plus diesel fuel oil (AN + FO) with separate placement of the components was used for the first

time. Advantages of the method include minimizing the ecological consequences of the large-scale blast and removal of the technological restrictions on the maximum time of using the AN + FO mixture. The dangerous zone was guarded by militia and was patrolled by helicopters, and the spread of the dust-gas cloud after blasting was also monitored by helicopters. The results of the blasting confirmed the accuracy of the calculations of the size of the charges and prediction of the configuration of the rock mound. A dam was formed which, after taking measures to make it watertight, will create a basin for seasonal regulation of the water of the Uch-Terek River, which will make it possible to deliver water to the villages and fields in 1991. (MacKeen-PTT)
W91-08027

8I. Fisheries Engineering

RECRUITMENT, GROWTH AND RESIDENCE TIME OF FISHES IN A TROPICAL AUSTRALIAN MANGROVE SYSTEM.
Australian Inst. of Marine Sciences, Townsville.
For primary bibliographic entry see Field 2L.
W91-07321

VERTICAL DISTRIBUTION OF PELAGIC JUVENILE SOCKEYE SALMON (ONCORHYNCHUS NERKA) IN KURIL'SKOYE LAKE DURING THE SUMMER-FALL PERIOD.
Tikhookeanskii Nauchno-Issledovatel'skii Inst. Rybnogo Khozyaistva i Okeanografii, Petropavlovsk-Kamchatskii (USSR).
For primary bibliographic entry see Field 2H.
W91-07397

HYDROLOGIC REGIMES OF VARIOUS TYPES OF SPAWNING GROUNDS OF SOCKEYE SALMON, ONCORHYNCHUS NERKA.
Tikhookeanskii Nauchno-Issledovatel'skii Inst. Rybnogo Khozyaistva i Okeanografii, Petropavlovsk-Kamchatskii (USSR).
For primary bibliographic entry see Field 2H.
W91-07398

FRESH-WATER FISH-POND MANAGEMENT IN THE WORLD.
Vyzkumny Ustav Rybarsky Vodnany (Czechoslovakia).
J. Matena, and R. Berka.
IN: Managed Aquatic Ecosystems. Ecosystems of the World, 29. Elsevier Science Publishing Co., New York. 1987. p 3-27. 11 fig, 1 tab, 99 ref.

Descriptors: *Carp, *Fish farming, *Fish hatcheries, *Fish management, *Fish ponds, *Reviews, *World regions, Africa, Asia, China, Commercial fish production, Europe, Historical perspective, India, Israel, Japan, Latin America, North America, Pond management, USSR.

A brief review on fish-pond management in individual world regions to demonstrate the capacity and production possibilities, and to look into the historical perspective of such fish-culture practices is presented. In Eastern Europe including the USSR, the main fish reared is the carp (Cyprinus carpio). Pond management practices in Western Europe differ from those of Central and Eastern Europe. Fish breeding in Asia especially in the regions of the Far East, has ancient roots going back to several thousands of years in China, and only somewhat less in Japan. The Asian continent has very favorable conditions for fish culture. In spite of favorable climatic conditions and potentially suitable vast water areas on the Indian subcontinent, pond fish culture is not as uniform as in other Asian countries. The Near East and the Middle East is a promising region for fish farming, though the present-day situation is far from satisfactory, with the exception of Israel which has one of the most advanced fish culture systems in the world. In the African continent, where fish often constitutes the main source of animal protein for man, commercial fish production is very insignificant. In America, successful spawning methods of the channel catfish (Ictalurus punctatus) which began in the 1950's, carp, and other freshwater species are described. In Latin America, Tilapia was introduced and now constitutes the largest proportion of fish cultured in the region. This region is among the continents having the greatest potential for fish farming, but for the time being the potential is exploited only minimally. (See also W91-07417) (Medina-PTT)
W91-07418

CARP PONDS OF CENTRAL EUROPE.
Karlova Univ., Prague (Czechoslovakia). Faculty of Science.
V. Korinek, J. Fott, J. Fuksa, J. Lellak, and M. Prazakova.
IN: Managed Aquatic Ecosystems. Ecosystems of the World, 29. Elsevier Science Publishing Co., New York. 1987. p 29-62. 22 fig, 5 tab, 146 ref.

Descriptors: *Carp, *Central Europe, *Fish farming, *Fish ponds, *Physicochemical properties, *Reviews, Austria, Bulgaria, Czechoslovakia, Fertilization, Fish populations, Germany, Hungary, Hydrogen ion concentration, Light, Nutrients, Oxygen, Phytoplankton, Poland, Temperature, USSR, Yugoslavia, Zooplankton.

In the context of fish farming, a fish pond is a man-made water body which is drainable and used for raising fish, especially the common carp. Carp ponds are found in Austria, Bulgaria, Czechoslovakia, Germany, Hungary, Poland, Yugoslavia and in the western part of the USSR. The abiotic environment, or the physicochemical properties of these ponds (morphometry and mixing, hydrology, temperature, light, oxygen and pH, nutrients and fertilization) and the biotic community (fish, phytoplankton, nannoplankton, macrovegetation and associated fauna, zooplankton, benthic fauna and bacteria) are reviewed. Important abiotic factors operate more or less uniformly in all the ponds within a given region, especially the seasonal course of temperature and the pattern of wind-induced mixing. The light regime is determined by absorption of the incident radiation, though this is modified as the zooplankton and the phytoplankton are affected by fish predation. There is no systematic difference in the supply of nutrients for phytoplankton growth. The source of nutrients is partly from fertilization of ponds, through additional feeding of fish with corn and granulated food, and by runoff from agricultural land. Every pond has a rich nutrient pool in its bottom sediments. Any classification of carp ponds according to trophic status is therefore meaningless. Therefore, the density of fish stock is considered as the main independent variable controlling the functioning of carp-pond ecosystems. (See also W91-07417) (Medina-PTT)
W91-07419

FRESH-WATER POND ECOSYSTEMS MANAGED UNDER A MODERATE EUROPEAN CLIMATE.
Instytut Rybactwa Srodladowego, Piaseczno (Poland). Zabieniec Centre.
K. Opuszynski.
IN: Managed Aquatic Ecosystems. Ecosystems of the World, 29. Elsevier Science Publishing Co., New York. 1987. p 63-91. 16 fig, 9 tab, 136 ref.

Descriptors: *Carp, *Europe, *Fish farming, *Fish management, *Fish ponds, *Trout, Climates, Cold water ponds, History, Physicochemical conditions, Warm water ponds, Wastewater disposal.

Fish ponds are ecosystems that are carefully controled in order to obtain optimal fish production. Fish ponds in Europe can generally be divided into two types: cold-water and warm-water ponds. The first serve for the culture of salmonids, of which the rainbow trout (Salmo gairdneri) is of special importance. The second type is mainly for the culture of cyprinids, with the common carp (Cyprinus carpio) as the most important species. Interestingly, neither of these species, which constitute the basis of fish production, is indigenous in Europe. The rainbow trout was brought from North America in 1880, whereas the carp was most probably brought to Europe in the Middle Ages from the Black Sea, Azov and Caspian Sea basins. Cold and warm water pond ecosystems are managed differently. Warm water ponds are more complicated ecosystems. The history of warm water pond management development, construction, production scheme, physicochemical requirements, and the corresponding biotic factors in the pond ecosystem are presented. Soil cultivation, liming, agricultural crop rotation and regulation of the physicochemical conditions of the pond are considered essential for obtaining maximum yield. The need for mineral fertilization is determined by the correlation between primary production and fishery production. Multi-species stocks and stocking rates, intensification of fishery production by perfecting biotechniques and the relationship between sewage purification and fish production as objectives for the future in managing pond ecosystems are important considerations. (See also W91-07417) (Medina-PTT)
W91-07420

MAN-MADE RESERVOIRS AS MANAGED ECOSYSTEMS IN TROPICAL AND SUB-TROPICAL INDIA.
Central Inland Capture Fisheries Research Inst., Barrackpore (India).
A. V. Natarajan, and V. Pathak.
IN: Managed Aquatic Ecosystems. Ecosystems of the World, 29. Elsevier Science Publishing Co., New York. 1987. p 93-109. 3 fig, 7 tab, 28 ref.

Descriptors: *Fish management, *Fish populations, *India, *Reservoir fisheries, *Reservoirs, *Subtropic zone, Ecological principles, Lentic environment, Lotic environment, Nutrients, Physicochemical properties.

Reservoirs are man-made ecosystems characterized by release of deep water, the existence of both lentic and lotic components, and wide seasonal fluctuations in water level which makes them ecologically distinct from their lake counterparts. The river-valley development projects undertaken since the independence of India that were designed to harness the immense potential of river systems for irrigation, power generation and water supply, and to control floods, have led to the creation of a number of impoundments in different parts of the country. A wide range of reservoirs in tropical and subtropical latitudes indicate that there are a number of environmental factors common to them. There are also a number of specific environmental characteristics that give each impoundment its individual character. Lack of understanding of the ecological principles, especially productivity characteristics during the ecological transition from lotic to lentic environments, and improper management practices have resulted in low fish yields (< 10 kg/ha/yr) in most of the Indian reservoirs. The implications of the ecology, the dynamics of physicochemical constituents, the flow of energy and nutrients, and aspects of fish capture and culture obtained from tropical and subtropical India are presented, based on observations in Bhavanisagar (Tamil Nadu), Nagarjunasagar (Andhra Pradesh), Rihand (Uttar Pradesh) and Govindsagar (Himachal Pradesh). Factors affecting productivity of economic carp are: (1) carp minnows and weed fishes; (2) undesirable fishes; (3) parasites; and (4) pollution. The ratio of fish production to primary production gives an idea of the scope for stock manipulation to enhance the yield. It is desirable to have a ratio of 4:1 numbers between primary consumers and other categories. (See also W91-07417) (Medina-PTT)
W91-07421

MANAGED COASTAL WATERS FOR OYSTER CULTURE IN JAPAN.
National Research Inst. of Aquaculture, Mie (Japan). Fish Nutrition Div.
K. Mori.
IN: Managed Aquatic Ecosystems. Ecosystems of the World, 29. Elsevier Science Publishing Co., New York. 1987. p 125-143. 3 fig, 8 tab, 35 ref.

Descriptors: *Aquaculture, *Coastal zone management, *Eutrophication, *Japan, *Marine resources, *Mollusks, *Oysters, *Resource management, Algae, Fish, Scallops.

Japan's extensive coastal waters available for aquaculture belong to the shore and the neritic regions. The coastal waters are utilized for culture of seaweeds including lavers (Porphyra), sea tangles (Laminaria) and wakame (Undaria), mollusks such as oysters (Crassostrea gigas) and scallops (Patinopecten yessoensis), crustaceans such as prawns (Penaeus japonicus) and fish including jack mackerel (Trachurus japonicus), sea bream (Pagarus major) and yellowtail (Seriola quinqueradiata). Aquaculture in Japan accounts for only a little less than 10% of the total fishery production. However, it is expected to increase continuously due to the great demand of high-priced aquaculture products. It is estimated that in the near future, the greater part of Japanese coastal waters will be managed for and through aquaculture. Bivalve mollusk culture is one of the most extensive types of aquaculture but is still regarded as a less productive method compared to other types of aquaculture. Therefore, some aspects of management practices in the coastal waters of Japan, biological characteristics of the Japanese oyster, (C. gigas), and practices used in its culture have been reviewed. It is concluded that although the possibility exists that artificial eutrophication in hanging-culture areas might increase the production of food required for the growth of oysters and promote culture production through a rise in fertility; in reality, eutrophication accelerates the proliferation of attached organisms which compete with oysters for food, and also induces excessive soft-body growth and over maturation of the gonad, resulting in certain physiological disorders and mass mortality. In addition, extreme eutrophication in the form of organic pollution may bring about the destruction of environmental conditions favorable to oysters. (See also W91-07417) (Medina-PTT)
W91-07423

FISH COMMUNITY OF TEMPERATE EUTROPHIC LAKES.
Lund Univ. (Sweden). Limnological Inst.
For primary bibliographic entry see Field 2H.
W91-07452

SPAWNING AND MOVEMENTS OF RAZORBACK SUCKER, XYRAUCHEN TEXANUS, IN THE GREEN RIVER BASIN OF COLORADO AND UTAH.
Fish and Wildlife Service, Vernal, UT.
H. T. Tyus, and C. A. Karp.
Southwestern Naturalist SWNAAB, Vol. 35, No. 4, p 427-433, December 1990. 2 fig, 1 tab, 29 ref.

Descriptors: *Colorado, *Endangered species, *Fish populations, *Habitat loss, *Sucker, *Utah, Environmental effects, Fish migration, Green River Basin, Radiotelemetry, Spawning, Water temperature.

Spawning and movements of the razorback sucker were evaluated by radiotelemetry (n = 17 fish) and capture of 230 adults (105 recaptures) in the Green and Yampa rivers, 1987 to 1989. Ripe fish (n = 194) were captured in riffles with cobble, gravel, and sand substrates from mid-April to early June. Recaptured males were ripe from 2 to 28 days and recaptured females from 2 to 15 days. Razorback suckers spawned during ascending and highest spring flows at water temperatures of about 14 C (range of 9 to 17 C). Spawning migrations of 30 to 106 km were detected in 17 razorback suckers, but movements were more limited or undetected in other individuals. Flooded lowlands and lower portions of tributary streams presumably served as resting-feeding areas for razorback suckers during the breeding season. Native flannelmouth sucker (Catostomus latipinnis), bluehead sucker (Catostomus discobolus) and putative flannelmouth x razorback sucker hybrids in breeding condition were collected with ripe razorback suckers. The Razorback sucker is in peril due to a paucity of spawning adults, hybridization with other suckers, little or no recruitment, and habitat loss. (Author's abstract)
W91-07577

AUTUMN SPAWNING AND OTHER REPRODUCTIVE NOTES ON LOACH MINNOW, A THREATENED CYPRINID FISH OF THE AMERICAN SOUTHWEST.
Arizona State Univ., Tempe. Dept. of Zoology.
S. P. Vives, and W. L. Minckley.
Southwestern Naturalist SWNAAB, Vol. 35, No. 4, p 451-454, December 1990. 1 tab, 27 ref.

Descriptors: *Arizona, *Endangered species, *Mexico, *Minnow, *New Mexico, *Stream biota, Fish behavior, Gila River, Habitat loss, Introduced species, Nesting, Spawning.

The loach minnow (Tiaroga cobitis) is a small (<70 mm), darter-like, rare cyprinid fish endemic to the Gila River basin of Arizona and New Mexico and of Sonora, Mexico. It is listed as threatened by the US Fish and Wildlife Service and endangered by the states of Arizona and New Mexico. Reasons for its decline are cited as habitat alteration and establishment of non-native fishes. Data on its biology are therefore important in formulating management and protection strategies. This species has only recently been reported as a hole-nester. Collections and observations made in Aravaipa Creek, a tributary of San Pedro River in Arizona showed that nest entrances faced downstream. Nest cavities were located beneath rocks embedded in the bottom on their upstream sides and slightly elevated on the downstream sides. Eggs were attached to a roof formed by the overlying rock and at or near the back of the cavity in 15 nests examined. The average number of eggs per rock was 63. Loach minnows spawn in late winter and early spring in Arizona. (Medina-PTT)
W91-07578

CHANGE OF THE LIFE CYCLE OF JAPANESE CHARR FOLLOWING ARTIFICIAL LAKE CONSTRUCTION BY DAMMING.
Hokkaido Univ., Sapporo (Japan). Faculty of Agriculture.
For primary bibliographic entry see Field 6G.
W91-08082

EFFECT OF ACID STRESS ON THE EMBRYONIC DEVELOPMENT OF THE COMMON CARP (CYPRINUS CARPIO).
Katholieke Univ. Nijmegen (Netherlands). Dept. of Biology.
For primary bibliographic entry see Field 5C.
W91-08158

PRELIMINARY STUDIES ON THE ACUTE EFFECT OF LINDANE (GAMMA-HCH) ON BRAIN SEROTONINERGIC SYSTEM IN RAINBOW TROUT ONCORHYNCHUS MYKISS.
Santiago Univ. (Spain). Dept. of Physiology.
For primary bibliographic entry see Field 5C.
W91-08160

PATHOLOGIC ALTERATIONS IN EARLY LIFE STAGES OF LAKE TROUT, SALVELINUS NAMAYCUSH, EXPOSED TO 2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN AS FERTILIZED EGGS.
New York State Coll. of Veterinary Medicine, Ithaca. Dept. of Avian and Aquatic Animal Medicine.
For primary bibliographic entry see Field 5C.
W91-08161

10. SCIENTIFIC AND TECHNICAL INFORMATION

10C. Secondary Publication And Distribution

BIBLIOGRAPHY OF ATRAZINE AND ITS SIMPLE DEGRADATION PRODUCTS IN THE ENVIRONMENT.
Geological Survey, St. Paul, MN. Water Resources Div.
P. D. Capel.
Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Open File Report 89-613, 1989. 200p, 2 tab, 5 ref, append. Includes four 5-1/4 inch diskettes.

Descriptors: *Atrazine, *Bibliographies, *Degradation products, *Fate of pollutants, *Path of pollutants, Agricultural chemicals, Databases, Herbicides.

Agricultural chemical contamination of surface water and groundwater is a topic of current concern. Agricultural chemicals have been observed in all components of the hydrologic cycle, establishing a need for research into their environmental fate and transport. Atrazine provides an excellent environmental surrogate of other herbicides. It has the appropriate set of physical and chemical properties to allow its movement within and between all environmental compartments (air, rain, soil, surface water, biota, and groundwater). Atrazine is also the most common organic contaminant in groundwater in the mid-continent of North America and is the second most popular herbicide in use. Citations from the scientific literature on the environmental behavior and occurrence of atrazine and its simple degradation products were obtained from three computerized bibliographic databases: Chemical Abstracts Service, Selected Water Resources Abstracts, and Agricola. More than 2,500 citations were categorized by environmental process, occurrence, analysis, toxicity or physical/chemical property. (Lantz-PTT)
W91-07225

WATER RESOURCES ACTIVITIES IN MICHIGAN, 1989.
Geological Survey, Lansing, MI. Water Resources Div.
For primary bibliographic entry see Field 7C.
W91-07826

10D. Specialized Information Center Services

LIST OF TERMS OF HYDROGEOLOGY, GEOCHEMISTRY AND GEOTHERMALS OF MINERAL AND THERMAL WATERS.
International Association of Hydrogeologists, Paris (France).
H. R. Langguth.
International Contributions to Hydrogeology Volume 3, 1984. International Association of Hydrogeologists, Hannover, Germany. 91p.

Descriptors: *Geohydrology, *Translations, Geochemistry, Geothermal water, Water resources.

For a better understanding between specialists of various countries engaged in the study of mineral and thermal waters, and also for use in geohydrology, hydrochemistry and geothermics, the compilation of a special terminological glossary was included into the program of the Commission for Mineral and Thermal Waters of the International Association of Hydrogeology as one of the principal items. At the first session held in Sofia (1970) the Commission decided to compile the glossary in the three major sections--geohydrology, geochemistry and geothermics of mineral and thermal waters. At the 1973 meeting of the Commission in Bad Driburg it was approved to elaborate: (1) a 'List of Terms' in five languages--Russian, French, English, German and Spanish--in a thematical order and an alphabetical order (with reference to the number in the thematical list); and (2) a 'Glossary of Terms with Definitions' in Russian, English and French. In this volume, the Commission publishes: (1) a complete list of terms; and (2) some examples in a glossary. (Lantz-PTT)
W91-07195

REPORT PLANNING, PREPARATION AND REVIEW GUIDE.
Geological Survey, Reston, VA.
J. E. Moore, D. A. Aronson, J. H. Green, and C. Puente.
Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Open File Report 89-275, 1990. 81p, 23 ref, 7 exhibits.

Descriptors: *Report preparation, *Reviews, Manuals, Standards, Writing.

The final report is the most important aspect of any project, because it generally is the only product of a project that a cooperator, client, or the public ever sees. Many reports, however, are poorly written and not completed in a timely manner because of inadequate attention to report planning and management. This guide was prepared to assist authors and reviewers in the planning and review of technical reports, and provides many common sense tools to help them produce quality reports on time. Project and report planning and organization are discussed first. Report writing and guidelines for writing selected parts of the report are covered next. The last topics covered are editorial and technical review. The guide contains examples of good and poor writing, report checklists, and source references to assist authors in the various stages of report preparation. (Lantz-PTT)
W91-07825

WATER-USE INFORMATION FOR THE MISSOURI RIVER BASIN.
Geological Survey, Rolla, MO. Water Resources Div.
For primary bibliographic entry see Field 6D.
W91-07902

10F. Preparation Of Reviews

LONG-TERM DEVELOPMENT OF FORESTED WETLANDS.
Eastern Michigan Univ., Ypsilanti. Dept. of Biology.
For primary bibliographic entry see Field 2H.
W91-07426

CONCEPTS IN WETLAND ECOLOGY.
Institute of Tropical Forestry, Rio Piedras, PR.
For primary bibliographic entry see Field 2H.
W91-07427

RIVERINE FORESTS.
East Carolina Univ., Greenville, NC. Dept. of Biology.
For primary bibliographic entry see Field 2E.
W91-07428

FRINGE WETLANDS.
Institute of Tropical Forestry, Rio Piedras, PR.
For primary bibliographic entry see Field 2L.
W91-07429

STRUCTURE AND DYNAMICS OF BASIN FORESTED WETLANDS IN NORTH AMERICA.
Illinois Univ. at Urbana-Champaign. Dept. of Forestry.
For primary bibliographic entry see Field 2H.
W91-07430

ECOLOGY AND MANAGEMENT OF SWAMP FORESTS IN THE GUIANAS AND CARIBBEAN REGION.
For primary bibliographic entry see Field 2H.
W91-07432

PALM SWAMPS.
American Museum of Natural History, Lake Placid, FL. Archbold Biological Station.
For primary bibliographic entry see Field 2L.
W91-07434

FORESTED WETLANDS OF MEXICO.
Universidad Nacional Autonoma de Mexico, Mexico City. Inst. de Biologia.
For primary bibliographic entry see Field 2L.
W91-07435

CARBON DYNAMICS IN EUTROPHIC, TEMPERATE LAKES.
For primary bibliographic entry see Field 2H.
W91-07447

PHYTOPLANKTON.
Aarhus Univ. (Denmark). Botanical Inst.
For primary bibliographic entry see Field 2H.
W91-07449

BACTERIA.
Copenhagen Univ., Hilleroed (Denmark). Det Ferskvands-Biologiske Lab.
For primary bibliographic entry see Field 2H.
W91-07450

ZOOPLANKTON.
Copenhagen Univ., Hilleroed (Denmark). Det Ferskvands-Biologiske Lab.
For primary bibliographic entry see Field 2H.
W91-07451

FISH COMMUNITY OF TEMPERATE EUTROPHIC LAKES.
Lund Univ. (Sweden). Limnological Inst.
For primary bibliographic entry see Field 2H.
W91-07452

WASTEWATER TREATMENT BY IMMOBILIZED CELLS.
For primary bibliographic entry see Field 5D.
W91-07454

MORPHOLOGY AND ELECTRON MICROSCOPY OF MICROBIAL AGGREGATES.
University of Western Ontario, London. Dept. of Chemical and Biochemical Engineering.
For primary bibliographic entry see Field 5D.
W91-07458

APPLICATION OF BIOMASS CARRIERS IN ACTIVATED SLUDGE PROCESS.
Toronto Univ. (Ontario). Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W91-07459

EFFLUENT TREATMENT WITH IMMOBILIZED MICROALGAE AND CYANOBACTERIA: A CRITICAL ASSESSMENT.
Laval Univ., Quebec. Faculty of Food Sciences and Agriculture.
For primary bibliographic entry see Field 5D.
W91-07460

IMMOBILIZED CELL SYSTEMS IN ANAEROBIC DIGESTION PROCESSES.
Biotechnology Research Inst., Montreal (Quebec). Environmental Engineering Group.
For primary bibliographic entry see Field 5D.
W91-07461

BIOLOGICAL PROCESSES IN TOXIC WASTE TREATMENT.
Windsor Univ. (Ontario). Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 5D.
W91-07462

EVALUATION OF DRY DEPOSITION, POLLUTANT DAMAGE, AND FOREST HEALTH WITH THROUGHFALL STUDIES.
Smithsonian Environmental Research Center, Edgewater, MD.
For primary bibliographic entry see Field 5C.
W91-07467

RATES OF NUTRIENT RELEASE BY MINERAL WEATHERING.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Crop and Soil Environmental Sciences.
For primary bibliographic entry see Field 5B.
W91-07469

EFFECTS OF ACIDIC DEPOSITION ON SOIL ORGANISMS.
Oregon State Univ., Corvallis. Dept. of Soil Science.
For primary bibliographic entry see Field 5C.
W91-07470

ECOLOGICAL BACKGROUND, DETERIORATION AND RECLAMATION OF DESERT DUNE SAND.
Ben-Gurion Univ. of the Negev, Beersheba (Israel). Dept. of Geography.
For primary bibliographic entry see Field 2G.
W91-07548

LABORATORY DIFFUSION TESTING FOR WASTE DISPOSAL: A REVIEW.
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5E.
W91-08039

SUBJECT INDEX

ABSORPTION
Determination of a Liquid State from that of a Liquid Solution Coupled to it by a Common Vapor Phase.
W91-07388 3A

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ACID DISSOCIATION CONSTANTS
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W91-07233 5G

Recovery of Acidified and Metal-Contaminated Lakes in Canada.
W91-07234 5G

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Improved Centrifuge Sludge Dewatering by Automatic Backdrive Torque Control.
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W91-07441 2H

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Response of Microbial Populations to Carbofuran in Soils Enhanced for Its Degradation.
W91-07130 5B

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Large, Retractable, Low Cost and Re-Locatable Rain Out Shelter Design.
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Determinations of Eligibility for Seven Bureau of Reclamation Dams in The Pacific Northwest Region: Deadwood Dam, Grassy Lake Dam, McKay Dam, Crane Prairie Dam, Wickiup Dam, Owyhee Dam, and Agency Valley Dam.
W91-07197 6G

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Subject Fields

1 NATURE OF WATER

2 WATER CYCLE

3 WATER SUPPLY AUGMENTATION AND CONSERVATION

4 WATER QUANTITY MANAGEMENT AND CONTROL

5 WATER QUALITY MANAGEMENT AND PROTECTION

6 WATER RESOURCES PLANNING

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1991 Price Schedules for the United States, Canada, and Mexico

These prices are for customers in the United States, Canada, and Mexico; other customers, write for price list PR-360-4.

Microfiche & Paper Copy Reports

Standard Prices		*Exception Prices*	
A01	$6.00	E01	$10.00
A02	11.00	E02	12.00
A03	15.00	E03	14.00
A04–A05	17.00	E04	16.50
A06–A09	23.00	E05	18.50
A10–A13	31.00	E06	21.50
A14–A17	39.00	E07	24.00
A18–A21	45.00	E08	27.00
A22–A25	53.00	E09	29.50
A99	*	E10	32.50
		E11	35.00
"N" Codes		E12	38.50
		E13	41.00
N01	$60.00	E14	45.00
N02	59.00	E15	48.50
N03	20.00	E16	53.00
		E17	57.50
		E18	62.00
		E19	69.00
		E20	80.00
		E99	*

Computer Products

Diskettes		*Magnetic Tapes*	
D01	$50	T01	$165
D02	80	T02	220
D03	130	T03	340
D04	180	T04	450
D05	230	T05	560
D06	280	T06	670
D07	330	T07	780
D08	380	T08	890
D09	430	T09	1,000
D10	480	T10	1,110
D11	530	T11	1,220
D12	580	T12	1,330
D13	630	T13	1,440
D14	680	T14	1,550
D15	730	T15	1,660
D16	780	T16	1,770
D17	830	T17	1,880
D18	880	T18	1,990
D19	930	T19	2,100
D99	*	T99	*

* Contact NTIS for price

Prices effective January 1, 1991

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